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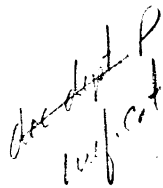

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THE POWER BEHIND THEIR WINGS

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THE POWER BEHIND THEIR WINGS

FIGHTERS

SPITFIRE HURRICANE

MUSTANG

*

FLEET AIR ARM

SEAFIRE FULMAR

BARRACUDA

*

NIGHT FIGHTER

DEFIANT

*

FIGHTER BOMBER

MOSQUITO

*

MEDIUM BOMBER

BATTLE

*

HEAVY BOMBERS

WELLINGTON WHITLEY

HALIFAX LANCASTER

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TRANSPORT

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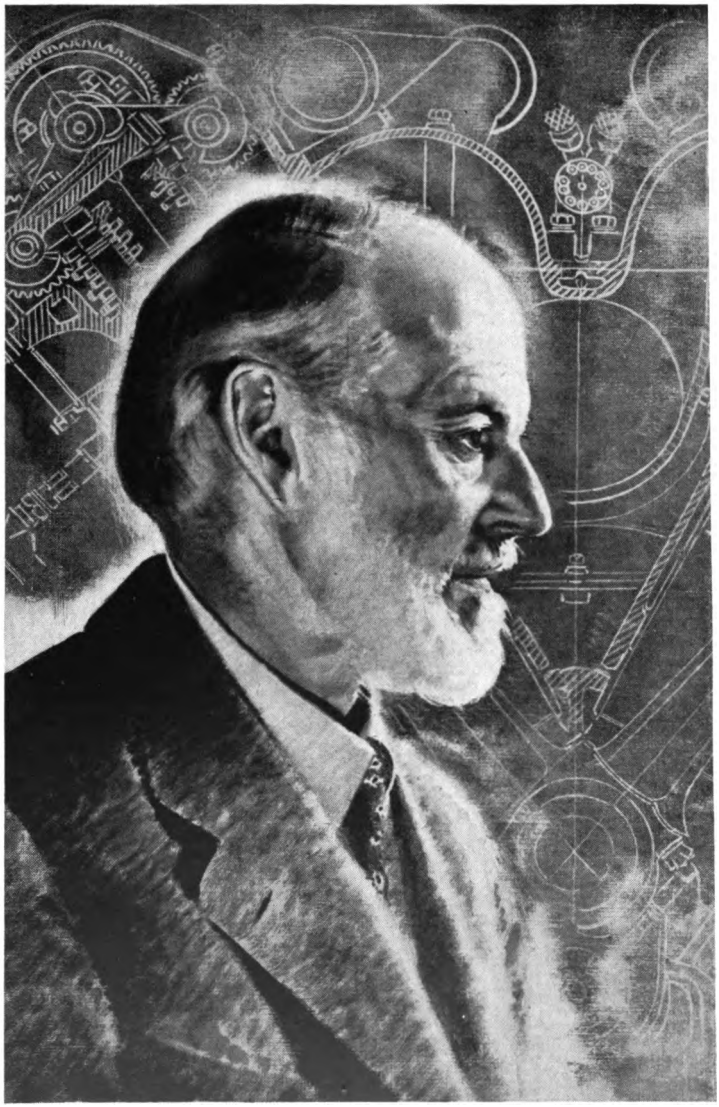

SIR HENRY ROYCE, Bart., O.B.E., M.I.Mech.E., M.I.E.E., M.I.Aer.E.

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THE

POWER BEHIND

THEIR WINGS

An account of the part played
by Sir Henry Royce
and the Rolls-Royce engineers in the
development of the in-line
liquid-cooled Aero-Engine
in Great Britain

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DOCUMENTS

FOREWORD

ON A SEPTEMBER DAY some thirteen years ago the peaceful air over the Solent was harshly disturbed by the whine of an aero-engine.

Across the water flashed a silver and blue monoplane that glinted in the sunlight, then dwindled rapidly away to a speck on the horizon, leaving a vibrating chord of sound behind it. It was a Supermarine S.6.B. Schneider Trophy seaplane powered by a Rolls-Royce " R " engine and flown by Flight Lieutenant G. H. Stainforth of the R.A.F. As the last echoes of its passage died away it was known that the world's air speed record had once again been captured by a British aircraft. And, for the first time, man had moved, in level, timed flight, at over 400 miles an hour.

Nine years later, in 1940, the September sky over the Solent reverberated again to the roar of Rolls-Royce engines at full throttle. But this time the sound was fainter, coming from a great height, and at intervals it was punctuated with an intermittent stuttering note.

Watchers on the ground, by this time well schooled in the sounds of the Battle of Britain, had no difficulty in recognising this as the rattle of the machine-guns on an eight-gun fighter. And they knew that the lazily interlacing white trails high overhead were the tracks of British and German planes diving and wheeling in furious combat.

Free people throughout the world know, and are thankful for, the victory won by British "Spitfires," "Hurricanes " and " Defiants " in this great air battle of 1940.

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It has been likened to Marathon, Trafalgar or the Marne —one of the decisive battles of history. The full explanation for this deliverance must be left for future historians to give. But two facts that cannot but be relevant emerge at once after the most cursory review. First, it is accepted by every expert that success in air combat depends greatly on the fighting qualities, speed and manœuvrability of the machines engaged. Second, it is known that every British aircraft that fought in the Battle of Britain was powered by a Rolls-Royce " Merlin " engine—the engine developed from the power unit of the Supermarine S.6.B. that won the world's air speed record for Britain in 1931.

The story of the " Merlin," therefore, may be instructive for those who want to look behind the facts of 1940, and learn something of the reason why Britain was able to snatch air superiority from so determined and thorough an enemy.

It is the story of an artist in machinery and how he established the standard of engineering excellence that has come to be identified by a name — Rolls-Royce.

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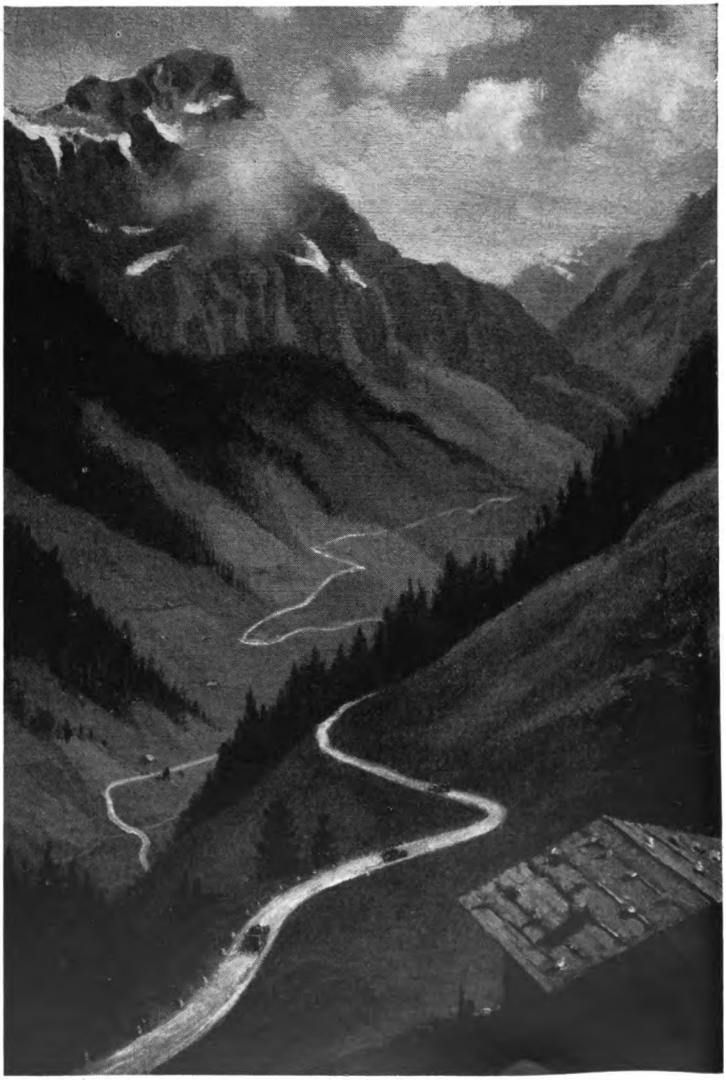

" The course included nineteen passes . . . considered to be the most formidable in the Alps."

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"SILVER GHOST"

The Birth of the Tradition

IN THE HISTORY of the internal combustion engine, one of the outstanding figures is that of the famous British engineer Frederick Henry Royce. But it was not until Royce was forty years old that he chanced to direct his inventive skill and knowledge of engineering practice to the development of the automobile. He came to the industry at the beginning of the century, when a motor car was still something of an oddity and the owner of one likely to find himself the target of the witticisms of his friends. When he died the aero-engines and motor cars made by Rolls-Royce, the company of which he had been the chief engineer for thirty years, had come to be regarded as among the finest engineering achievements of all time.

The "Merlin" engine was developed after the engineer's death in 1933. But the logic and beauty of its design are derived from the engine created by Royce for the Schneider Trophy race. It owes its excellence to the production traditions he founded thirty years previously when he set out to design and build motor cars. The story of the "Merlin," then, can rightly begin with an account of the great engineer's career and the days that saw the production of the first Rolls-Royce cars.

In early life Henry Royce suffered poverty, lack of any proper education, long hours of work and unemployment. In later years—due to the hardships endured during those

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formative days—he had to work under the handicaps of continued ill health. From the age of four to nine he had but one year's schooling. From ten to eleven he was earning a living selling newspapers. His inadequate schooling was resumed for one year from eleven to twelve ; from thirteen to fourteen he was again at work—this time as a telegraph boy.

But a world of mechanical wonders was suddenly opened up to the gifted youth when he was apprenticed, at the age of fourteen, in the locomotive works of the Great Northern Railway at Peterborough. At that time, in 1877, two famous British railway engineers—Gooch and Patrick Stirling—were building their engines. And young Henry Royce must have learnt, even at that early age, how closely the business of designing was connected with the development of better materials. For one of his earliest jobs was to assist in the conversion of Stirling's engines from coupled to single driving wheels because the steel connecting rod between the coupled wheels would not stand up to the stresses imposed. It was a lesson he never forgot. Throughout the whole of his career as a designer he never ceased in his search for better materials or in his insistence on the highest quality of metal even in the smallest components. Indeed, part of his great success was due to the wonderful knowledge of metals and their characteristics which he acquired in years of patient experimental work. In those workshops at Peterborough, too, he laid the foundations of his skill as a mechanic. When he left them at the age of seventeen, he had acquired, in his own words, " some skill as a mechanic

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but lacked technical, commercial and clerical experience."

He does himself scant justice, for already he had proved himself a clever workman and was highly thought of by his foreman. Already he had begun to use tools with the remarkable dexterity that earned the respect of his best workmen in later years. Already the standards of precision that are to-day associated with the name Rolls-Royce were taking shape as the young mechanic patiently filed with an accuracy that even to-day could not be bettered by a modern machine tool.

He had also begun that hard process of self-education which gave him the necessary scientific and theoretical knowledge upon which he could depend for the guidance of his brilliant practical intuitions as a designing engineer. He was attracted by electricity—that fast-developing field of experiment and research in the seventies and eighties of the last century. Somehow, often it must have been by long hours of solitary study after a hard day in the workshop, he added a specialised knowledge of electricity to his general grounding in engineering. When he left the locomotive works, and after a short period of unemployment followed by work with a firm of toolmakers, he became an electrician.

His inventive genius quickly began to assert itself. At the age of twenty he was chief electrician to an electric company at Liverpool and there made some important investigations into the three-wire system of conduction, sparkless commutation, and the drum-wound armature for continuous current dynamos. At the age of twenty-one he founded his own business in Manchester and began to

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design and manufacture electrical equipment that was outstanding for the excellence of its workmanship. For many years he carried on this business, steering it through good times and bad, and succeeded at last in winning a considerable reputation, in Britain and abroad, for Royce electrical apparatus. He designed and built a new type of electric crane and an improved type of dynamo. He insisted on the highest standards of engineering in his workshops, so that a Royce crane or dynamo was sure to be the best type of apparatus of its kind both in its original design and the care with which it was made. He always refused, even in the face of fierce competition, to cheapen the price of a Royce product by altering the design or lowering the standard of workmanship and the quality of the materials used. Nor could he rest once his inventive brain had suggested some detail improvement —it must be incorporated at once in the production model. Such, then, was this British engineer, and such was his engineering philosophy when, at the turn of the century, he began to interest himself in the internal combustion engine.

As far back as 1876 Otto had designed the four-cycle gas engine. But it was not until 1889 that an internal combustion engine working on the four-cycle principle—suction, compression, explosion and exhaust—had really excited sufficient interest in the engineering world to lead to its rapid development. By the beginning of the twentieth century development had reached the stage where it was possible to foresee the growth of a great new industry. Panhard, Levasseur, De Dion and Peugeot were

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already well-known names in France. In Great Britain, Daimler, Napier, Wolseley and Lanchester were making cars for sale to the general public. They were weird-looking contraptions—but they worked. In 1895 M. Levasseur had won a Paris to Bordeaux race and, in the words of the report at the time, " the general mean of his velocity " was given as the terrifying speed of 19·91 miles an hour !

In 1903 Henry Royce was forty years of age—and in the prime of his powers. And in that year he bought his first motor car, tried it, stripped it down, examined it, and decided that he could build a better one. About a year later he drove out of his electrical works at the wheel of a car built entirely to his own design and under his own eye. It had a two-cylinder water-cooled engine with overhead inlet valves. With a bore of 95 mm. and a stroke of 127 mm. it was rated at 10 h.p. Royce designed his own carburettor, made his own coil and distributor for the battery ignition, and designed his own three-speed gearbox. The complete car was in no way revolutionary, but the touch of a master hand in its design was seen the moment the little car took the road. Its silence and smoothness were in marked contrast to the noisy clanking and mechanical clatter that were usually associated with the " horseless carriage." The application of the Royce principles of engineering, developed in his electrical works, had helped to transform the unreliable, fussy, noisy motor car into a reliable, smoothly functioning machine.

Within two years Royce had designed the 40/50-h.p. six-cylinder car that became known as the " Silver Ghost." It is a matter of history that no car before or

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since has won such fame. Every component in the completed design came under the great engineer's scrutiny. Every profiling, turning, milling and grinding operation had to be carried out to the exact limits he set down. Many of the tolerances decided upon—some as close as one ten-thousandth of an inch—had never been considered necessary in motor car work up to that time. The car was made in a new factory at Derby laid out by Royce himself and described at the time as the best planned and equipped factory to have been built in the motor industry.

Henry Royce was now in association with the Hon. C. S. Rolls, a daring and experienced racing driver of the period, and the name Rolls-Royce had already been adopted. Rolls won a number of road and track races in Britain and America on cars built by his firm. But he turned his interest to flying after meeting the famous Wright brothers in 1908. He made the first two-way crossing of the English Channel and took part in many flying meetings. At one of these, at Bournemouth in 1910, he met his death in a flying accident at the early age of thirty-three. It is of interest that Royce, who was to play so notable a part in the development of aviation, was thus associated with a pioneer in the earliest days of flying.

At that time, however, he was concentrating on the building of cars, and within the space of two years Rolls-Royce products made a deep impression on the motor industry. But it was with the coming of the " Silver Ghost " that the Rolls-Royce tradition was born. The basic design of the complete car was so sound in

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conception that it remained substantially unchanged for nineteen years. But no year passed without the great engineer finding some detail to improve, some refinement to add. The whole of the company's growing resources were concentrated on the improvement of this one design. With an almost superhuman patience Royce strove to improve upon perfection. And so, over the years, a car was evolved that came to be regarded, by common consent, as a masterpiece.

This reputation was based on the record of the car's performance. As early as 1907 a Rolls-Royce " Silver Ghost " had been driven 15,000 miles, over 14,371 miles of which the engine had never stopped running. This was the equal of three years' normal wear in an owner-driver's hands. The car was then submitted to inspection by the Royal Automobile Club, whose engineers were asked to strip down the complete car and replace every part that showed the slightest sign of wear so that the car would be " equal to new."

The examination showed that infinitesimal wear (a fraction of a thousandth of an inch) had developed in part of the steering and universal joints. The water pump needed repacking. It was thought necessary to grind in the valves. The total cost of replacement was £2 2s. 7d. No car up to that time had ever been submitted to so searching a test—and the result of it amazed the engineering world. In 1911 a standard car was driven at a speed of 78·26 miles per hour. In the same year a stock car, with lightened body and slightly higher gear ratio, but otherwise untouched, reached 101 miles per hour.

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In 1912 the Austrian Alpine Trial, described as the most strenuous test of a car's performance arranged up to that year, excited the greatest interest in motoring circles throughout Europe. In 1913, therefore, an official team of three Rolls-Royce "Silver Ghosts" was entered against teams from all the finest Continental makers of the day. One other "Silver Ghost" was entered by a private owner. The four Rolls-Royce cars dominated the trial. The course included nineteen passes, some of them —such as the Tauernhöhe, the dreaded Katschberg, the Stubalp and the Brenner—were considered to be the most formidable in the Alps. Henry Royce's great cars swept up the long and difficult ascents with ease. Not only were they far faster than any other car—their silence and smoothness amazed onlookers used to the roaring exhausts of the big Continental machines. Bonnet to tail the four Rolls-Royce cars flew up pass after pass, running with monotonous regularity, easily ahead of all other competitors. Their performance throughout the trial was so outstanding that in every European capital motoring circles echoed with praise of the "wonderful British Rolls-Royces." By 1914, at the outbreak of the last war, the "Silver Ghost" had a reputation that was international. But henceforth Rolls-Royce was to be a name famous not only on land but in the air.

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"EAGLE"

The Growth of the Tradition

WITH THE OUTBREAK OF WAR in 1914 certain far-sighted authorities in Britain could see that aircraft were likely to play an increasingly important part in military operations.

Then, as now, emphasis was placed on performance and quality—no pains were to be spared to put into the hands of the pilots the finest machines that British engineering genius could evolve. It was natural that Britain's foremost automobile engineer should be one of those called upon to assist in the designing and building of the power units for those planes.

In 1911 Royce's health had broken down. He survived a severe illness and pulled through a major operation by sheer will-power. His health was permanently affected, however, and for two years he had controlled the designing and experimental departments of Rolls-Royce from the South of France. But his country needed him, so he hurried home and settled down to a year of the most concentrated mental and physical effort that he had ever been called upon to face.

Uppermost in his mind was his desire to serve Britain. But the challenge of an entirely new set of problems awaiting solution must have had its attraction for the great designer. Here were new lessons to be learnt, more experience to be gained.

The very difficulties inherent in designing a power unit

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" Most spectacular demonstration of aero engine reliability . . . when two British R.A.F. officers completed the first direct crossing of the Atlantic by air."

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for an entirely different purpose fascinated him. He set to work at St. Margaret's Bay, where he lived quietly, surrounded by a team of assistant engineers and draughtsmen. No feat of concentration or effort of the human will can have surpassed in intensity the twelve months during which the great engineer was designing and perfecting his first aero-engine. The basic type of engine chosen was a water-cooled twelve-cylinder in two banks of six mounted in V formation at an angle of 60 degrees on the crankcase.

Many factors were taken into consideration in selecting this type, and the logic of the choice may be said to be proved by the fact that the " Merlin " of the present day is an exactly similar basic type. After a quarter of a century of development in the most progressive of all industries, there has been, up to the present, no sufficient reason for Rolls-Royce designers to change the basis of the design first laid down by Royce.

Rapid progress was made on the design of the " Eagle," as it was called, and scarcely six months after Royce started work an experimental engine was running on the test bench at Derby. Royce had conservatively anticipated 200 h.p.—for those days a truly terrific power output. The first full power test showed 225 h.p. at 1,800 r.p.m. By the time the engine was in production the power output had been raised to 255 h.p. and by the end of the war, without any radical change in design, the " Eagle " was giving 360 h.p.

The " Eagle " showed the familiar Rolls-Royce features —proven design, microscopic attention to every detail,

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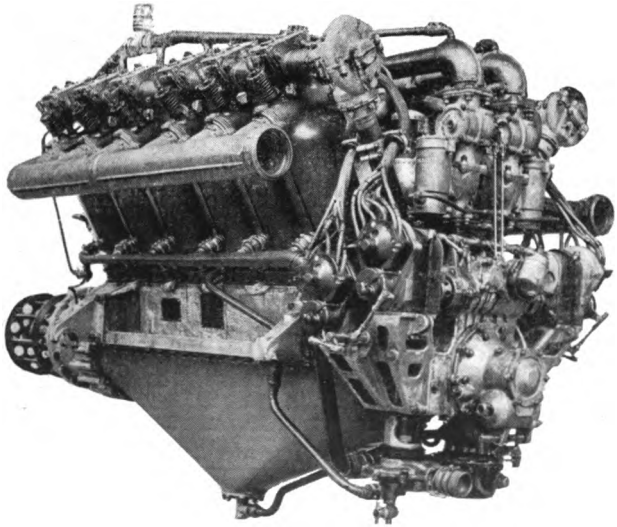
impeccable workmanship. The margin of safety to which it was designed and built was the means of saving many a pilot's life. Machines returned to their base with parts of the engine shot away—indeed, the designer had allowed for just this eventuality. At a time when engine failures were frequent, the reliability of the "Eagle" astounded the engineering world and won the confidence of every British airman. All the twin-engined night bombers that were used in 1918 to strike heavy blows against German industries and German morale were powered with "Eagle" engines. Rolls-Royce engines often gave 150 flying hours—a remarkable duration at



The "Eagle," Henry Royce's first aero-engine. The "Merlin" of to-day is of the same basic design, but the complete power output of the 1916 "Eagle" would be required to drive the supercharger alone of a modern "Merlin."

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that time. It was estimated that well over half the engines used in British aircraft during the last war were designed by Royce, for in addition to the " Eagle " he produced the smaller 75-h.p. " Hawk " for use in " Blimps "—non-rigid airships used for reconnaissance work and sub-marine spotting. He also produced the 200-h.p. " Falcon " and towards the end of the war the great Rolls-Royce " Condor " 600-h.p. engine. This was intended to power the aircraft that were meant to bomb Berlin. The Armistice was signed before the engine could be put in commission, but it became a standard power unit for R.A.F. bombers after the war.

Because of its great war service British pilots had good reason to know the qualities of the " Eagle." But the most spectacular demonstration of aero-engine reliability to the world at large took place in 1919, when two British R.A.F. officers completed the first direct crossing of the Atlantic by air. John Alcock and Arthur Whitten Brown, flying in a Vickers " Vimy " bomber powered by two 360-h.p. " Eagle " engines, completed the flight from coast to coast in 15 hours 51 minutes. The engines gave them not one moment's anxiety. It was eight years later before any other machine equalled this feat.

The great engineer had not finished his work, however, and in imagination he must already have seen far down the path of development that lay ahead. And so the Rolls-Royce tradition grew with the production of a line of aero-engines, each one of which, springing logically from the original " Eagle," carried the basic design one step nearer to the " Merlin."

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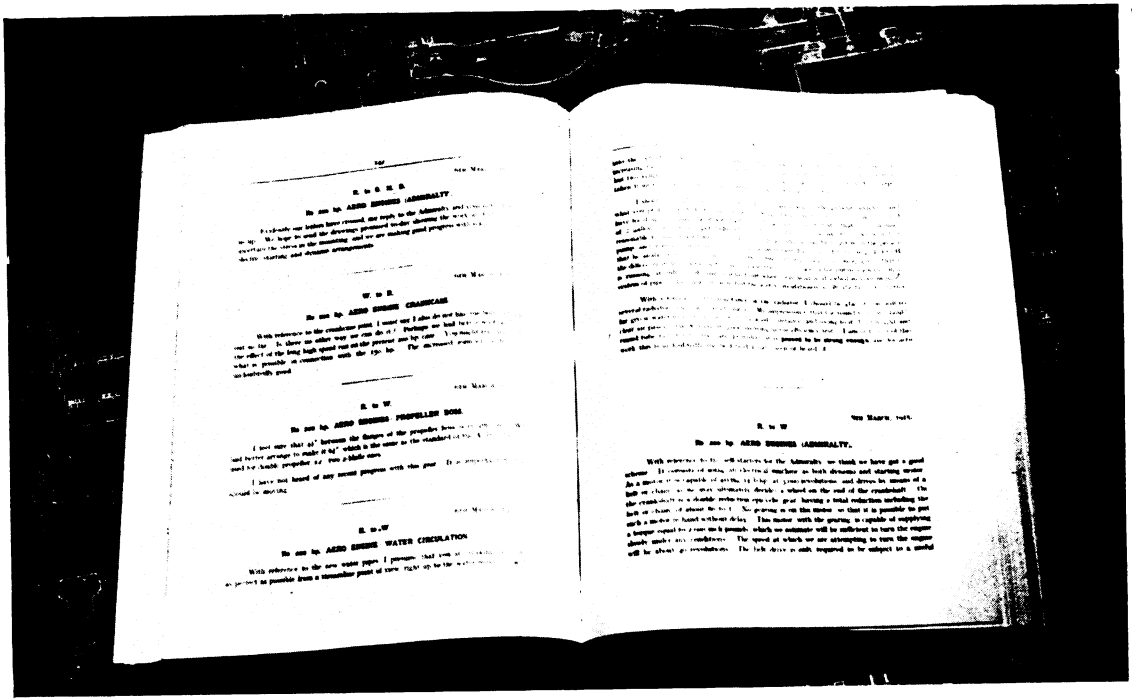

"The book has come to be known among the staff as the Rolls-Royce ' Bible.'"

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THE "BIBLE"

Record of the tradition for the guidance of engineers selected to uphold it

WHILE ROYCE was designing the "Eagle" aero-engine, he was obliged, for reasons of health, to work in seclusion away from the workshops and experimental benches at Derby. This necessitated a steady stream of letters and memoranda to the factory and certain Government departments as the designing proceeded. On the completion of the work the papers were collected and printed in a substantial, leather-bound volume of 301 pages measuring 12 inches by $9\frac{3}{4}$ inches. A few copies were issued and are kept permanently at the works for reference to this day. The book has come to be known among the staff as the Rolls-Royce "Bible." Probably no more fascinating document has been produced in the history of engineering. Here is the preface defining its purpose. "In the opinion of the Board of Directors, the Memoranda and Letters written by Mr. F. H. Royce, the Engineer-in-Chief, in connection with the design, testing and manufacture of these Engines, are so admirable as evidence of extreme care, foresight, and analytical thought, that the Directors decided to have them printed and bound in order that copies may be available for study and as an example to all grades of Rolls-Royce Engineers, present and future.—December 1915."

From these pages there emerges an unmistakable

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picture of a great artist in machinery at work. A reading of them is of peculiar value for the young engineer even of to-day. It is as though an art student could still look over the shoulder of a Rembrandt as he wields his brushes ; or the young scientist could still assist at the experiments of a Faraday.

Here everything is touched upon that comes within the province of the designer, the experimental engineer, the metallurgist, the production organiser, and even the fitter at his bench. Advice is given on the rigging up of experimental tackle, the making of jigs for test work, the designing of machine tools ; he deals, even, with the planning of workshop production and the very methods to be adopted by the individual workman. Here is seen the logical approach to each problem, the patient correction of theory by experimental results, the refusal, always the refusal, to allow production to start until he is satisfied that a component cannot be improved. " We must spare no expense or trouble," he writes, " in getting the parts as perfect as possible. Economy must come afterwards, in good workshop methods." Again : " Spend all the money and time necessary to make a good and reliable working job of the highest possible efficiency." Nothing is to proceed on the basis of theory or intuition alone ; even his own sure judgment and vast fund of knowledge are no substitute for recorded results from the test bench. " Experiments produce the only safe results to follow." " There is no safe way of judging anything except by experiment." It is the cautious scientific approach ; the detached objective

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viewpoint that cannot cling obstinately to a theory that has been disproved by the hard reality of the facts. It was said that he never had a failure of design—certainly not one that reached the production stage. Yet he writes : " My faith in my own scheme is not always sufficiently great to make me abandon well-tried practice for my own or others' novel schemes and constructions." His knowledge of the composition and qualities of metals was immense. He gives precise instructions for the use of a " very, very mild iron. This I mean to be the same material as is used for horseshoe nails." Or he calls for steel containing " almost ·4 or ·6 per cent. carbon, something like tyre steel." He refers to steel being " more pure as if it had a Swedish charcoal iron origin." He knows just how certain metals are likely to behave. " I would not recommend that the bars for piston rings were subject to any bright drawing or reeling, which is apt to crack the metal."

It is an interesting fact that good engineering design has a certain cleanness of line, and that the best designers seem to have almost an artist's eye for form. Royce was never satisfied with a component unless it looked right, and he never was tired of repeating : " If a job is designed correctly it should look right." He writes of some steel pressings : " I have the impression these are not as shapely as they might be, and I hope that when we settle down in the matter we shall be able to get them in better form." He discusses details of design with a sort of affectionate intimacy. " If we could easily manage it, it would be nice to oil this camshaft with a little

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plunger pump." He knows from long experience how often machinery can seem to behave in a capricious or positively malicious spirit; and he sends a word of sympathy to the harassed experimental engineer: "Certainly the top water pipe seems a terrible sinner some way or other, and it would appear there is some mystery about it."

Designing an engine is one thing. Designing the tools and planning the sequence of operations necessary to make it in quantities is another. Royce was a fine organiser of production with a keen eye for a good machine tool. "Be sure you make these tools as simple as possible, but let them be really nice for the job. I think the one for drilling the sparking plug hole is rather crude." Every jig and tool came under review. "With reference to blue-print, I am not struck with this jig as being the best to be made for the purpose, and I send you herewith a suggestion for one of another type." Or again: "I think the arrangement you show is very ingenious, but I do not think it is quite the best for the purpose. If carelessly tightened it could drag the pin out of the centre." His sense of form extends even to the machine tools. "Referring to the rotary table, I do not like the lumpy construction. It produces unsound castings, is heavy to handle, and requires a big counterweight."

On nearly every page of this volume there is some piece of practical advice or instruction on the job in hand which, because of the engineering principle it expresses, can serve as a maxim for the young designer. In one chance sentence Royce's whole engineering doctrine is summed

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up, and the method of the master engineer is strikingly revealed. Writing to the factory about a component that has been the subject of much correspondence, and which has been made over and over again, he says at last: "You have evidently got it right this time, *but I think you can improve it in the following way.*" Even when working under the greatest pressure nothing is to be considered as right, if it can be improved.

The picture of Royce as a great designing and production engineer emerges from the pages of this memoranda. And great designer he must have been, for something like 250 British patents have been filed in his name. Yet he himself liked to be known as a mechanic. A brilliant workman himself, he always had a word of praise for a job well done. He chose as a motto to be carved on his mantelpiece the words: Quidvis Recte Factum, Quamvis Humile Praeclarum—"Whatever is rightly done, however humble, is noble." He could walk up to any machine tool in the factory and operate it perfectly. It is recorded that he once filed a hub cap into a faultless hexagon so that the gauge fitted exactly on any dimension. Because he was so fine a mechanic himself his workmen accepted willingly the discipline and standards he imposed. He was ruthless in his condemnation of slipshod workmanship, or even anything that fell below a man's best. Royce had heard a mechanic remark that a job he had just completed on a car was "good enough," and forthwith, in the words of an eyewitness, "F. H. R. carried on in an alarming manner." On another occasion he found that a front axle on an experimental car had been bent half

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an inch to make it agree with a drawing dimension. He immediately called together everybody working on cars and read them a sermon on " this foul practice " ; then, in spite of the fact that all experimental work would be held up, he scrapped the maltreated axle completely. Walking through the works one day he chanced to see a man unwinding a reamer from a hole instead of withdrawing it in the correct way. For this mortal offence against the canons of good workmanship the luckless mechanic was dismissed on the spot.

So by strict workshop discipline, but mainly by the example of his own matchless competence, the great engineer inspired all his workpeople with his own enthusiasm and care for detail. His attitude to the men who built his engines was summed up in an interview he gave at the time of the Schneider Trophy race. " The designers," he said, " are not the most important part of the business by any means. What I mean by that is this ; you may design an engine, but after that you have got to find men who can make it. The design of this engine is really quite simple, but only the finest engineers could make it effective." A tribute paid with typical modesty from the founder of the Rolls-Royce tradition to the British workmen whose patient, conscientious skill still keeps it alive.

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ALLOYS

By-product of the Search for Perfection

ON LOOKING AT A PIECE of machinery a layman is apt to admire it for its solid and massive construction. For him, weight means strength. The engineer takes rather a different view. For him, weight in moving parts means so much more inertia to be overcome. Power used to move unnecessary weight is power wasted. In the designing and building of an aero-engine, the whole weight of which must be lifted off the ground by the power it produces, lightness of construction is of vital importance. The principle of building as light as safety would permit was applied by Henry Royce from the very beginning of his designing career. His first cranes were built with a kind of trellis girder construction in marked contrast to the massive constructions in use at that time. He used bracing, struts and cross-ties scientifically to take strains and stresses. Buyers at the time considered his cranes so " spidery " in appearance that they could not believe them capable of lifting the weights for which they were designed. Yet Royce was able to demonstrate experimentally that his light construction gave far greater lifting power, with an even greater margin of safety, than the heavy looking solid jobs that usually took the buyer's eye.

To build as light as possible became a cardinal principle of his automobile designs. Indeed, he would build an engine lighter than seemed theoretically possible, then

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run it to destruction in order to obtain experimental data. In the days of experimental work on cars he would pick up from a bench a component that appeared to him too heavy for the job it was designed to perform, and stalking through the factory with it in his hand would ask in withering tones, " Who is the author of this ' sinker ' ? " By the time he was designing his first aero-engine aluminium alloys were coming into use for automobile work, and he eagerly experimented with the first aluminium pistons. Metallurgical research he had always regarded as of the greatest importance. In the earliest days of experimental work on cars he kept a small furnace at the works for investigating the heat treatment of metals—an unheard-of refinement of practice in the industry at that time. By 1916 a research unit had been established at the Rolls-Royce works solely for the purpose of developing the lighter and better alloys that the great engineer needed to improve the power-to-weight ratio of his engine.

To-day this small unit has become a fully equipped and staffed laboratory with over a quarter of a century of intensive research work behind it. Indeed, it is probably one of the best equipped laboratories of its kind in Britain. No single firm has contributed more to the engineer's knowledge of alloy metals and their behaviour under the stresses set up by the internal combustion engine. There are now in existence sixty-five Rolls-Royce patents, covering sixty-five different specifications for aluminium alloys, and R.R. alloys, as they are known, are made under licence all over the world. So important is this weight factor to the design of aero-engines that it can fairly be

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claimed that the " Merlin " engine could not have been produced if R.R. alloys had not been developed capable of standing the immense stresses undergone by reciprocating and rotating parts in a high-output aero-engine. The " Merlin " with propeller, weighing around one ton, produces more horse-power than an express locomotive weighing ninety tons. The engine itself takes up no more space than a single bed. The miracle of packing such colossal energy into an engine so compact and light has been made possible by the use of R.R. alloys.

The aircraft industry itself owes much to the great engineer's insistence on metallurgical research. For it is probably true to say that every Allied aircraft flying contains, somewhere in the construction of its engine and airframe, one of the famous R.R. alloys. So, in the search for perfection, in the determination to maintain the tradition, a completely new avenue of development was opened up by the great British engineer and his team of assistants.

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" Royce, with his keen appreciation of form, was determined that nothing should spoil the beautiful aerodynamic lines of the Supermarine S.6.B."

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THE SCHNEIDER TROPHY

400 m.p.h. More than thirteen years ago

THE " EAGLE " was the first of a line of aero-engines which included the " Falcon," the " Kestrel," the " Buzzard," the Rolls-Royce racing engine for the Schneider Trophy, and then the " Merlin." Into the design of each as it appeared was poured the accumulated knowledge and experience gained from the performance of its predecessors.

But the period of most intensive development work came with the designing of the first racing engines built by Royce for the Schneider Trophy races of 1929 and 1931.

The building of a few special racing engines sets a different set of problems from those encountered in producing engines in quantity for day-to-day service. But in solving them, the engineer acquires much valuable knowledge that can be used to improve production types. He can use special fuels, increase engine speeds, boost up power, and experiment with lighter materials. His engine, given a necessary margin of safety, need only last for the duration of the race. From the failure of his racing engine working under hitherto untried stresses he can discover hidden weaknesses in design or faults in materials. To the layman, conscious of the Derby tradition, it seems almost scandalous to talk of the " failure " of a Rolls-Royce engine. But experimental engines are expected to fail. Testing for destruction was continually used by

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Royce when he was developing a design. Failures and troubles at the experimental bench never worried him. For he never doubted that the knowledge to be gained from them would enable him to overcome all troubles in the end. His patience was inexhaustible, his confidence in ultimate success an inspiration to all who worked with him.

The difficulties surmounted and the problems solved during the development of the Rolls-Royce " R " engine for the 1931 Schneider Trophy race necessitated design attention to practically every component of the engine. Yet that engine had been good enough to give 1,900 h.p. and win the race for Britain at 328·63 m.p.h. in 1929. Indeed, it was so far in advance of all competitors that no country was prepared to fly against Britain in the greatest of all international air tests in 1931. But Royce and his designing team were not content with the 1929 world's speed record of 357·7 m.p.h.

In advance it was decided to build another Rolls-Royce " R " engine that would give well over 2,000 h.p. and that would fly at over 400 m.p.h. To obtain this performance the engine speed was raised, the supercharger gear ratio increased and the size of the air intake enlarged. When these decisions were taken about nine months were available for designing and experimental work—and into this nine months it has been estimated that five years' normal development was crammed.

By April, with the race only six months ahead, the engines running at full power would last only 20 minutes before some kind of failure occurred. By the middle of July they still lasted only half an hour. By August 3rd

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a run of 58 minutes at 2,360 b.h.p. was accomplished —two minutes short of the one hour considered necessary to give the required standard of reliability. On August 12th—exactly one month before the date of the race—a full hour's non-stop run at 2,350 b.h.p. was recorded.

During these experimental trials redesigning was continually in progress. A " Life of Parts " list was drawn up giving the anticipated life of each component under testing. To save time in rebuilding wrecked engines, each part was replaced when its expected duration had been reached. This experimental work led to hundreds of refinements in design. An entirely new type of connecting rod was developed. Crankcase and crankshaft design was modified to withstand the immense load of nine tons that had to be taken by the centre main-bearing. A fully balanced crankshaft was found necessary to ease this bearing load, and special research had to be made into bearing metals. With the increase in engine speeds on the 1929 engine, the oil consumption suddenly jumped from 7 gallons to 50 gallons an hour. This was due to oil being flung out of the crankcase breathers. On one run of 25 minutes oil consumption rose to 112 gallons an hour and the whole test house was smothered in oil at the conclusion of the test. Weeks of intensive experiment and development work were carried out in the design of scraper rings, breathers, the scavenging system and crankcase capacity. Oil consumption was finally reduced to 14 gallons an hour.

Trouble with valve springs occurred with the increased r.p.m. and a special experimental rig was used for

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nothing but spring testing until the right type of spring could be found.

The exhaust valves in such a high-output engine work continually at a dull red heat and this resulted in detonation—the "pinking" every motorist has experienced. To overcome this trouble, sodium-cooled exhaust valves were used—a type of valve with a hollow stem filled with liquid sodium which helps to dissipate heat by conducting it away rapidly down the stem of the valve to the valve guides.

So trouble after trouble was experienced in the testing house—and its solution found by work on the drawing board, in the metallurgist's laboratory, or in the experimental workshops. The results of the intensive research were seen, not only in the engine's performance on the day of the race, but in its condition when stripped down at Derby afterwards. No defects were evident, and it appeared likely, neglecting the possibility of fatigue in the metals, that the engine could be reassembled to repeat its performance over again. But even when the bench tests were considered satisfactory there were still many problems to be faced before the engine could be installed in the plane for its flight tests. So closely did the engine fit into the space provided for it in the fuselage that an alteration that changed the engine contour by even as little as a quarter of an inch might result in the fouling of an internal spar or rib in the fuselage. Allowance had to be made for expansion of the crankcase when the engine was hot. This expansion, measured longitudinally, amounted to fifteen-hundredths of an inch.

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To save valuable time on the flight tests an exact replica in wood of the front part of the fuselage with every internal spar and rib in position was built by the Supermarine Aviation Company and sent to Rolls-Royce for experimental installation work. The completed engine fitted so tightly that it took the installation crew about half an hour to lower and coax it down for the last six inches on to the engine bearers. Royce, with his keen appreciation of form, was determined that nothing should spoil the beautiful aerodynamic lines of the Supermarine S.6.B. He always worked in perfect harmony with the brilliant young aircraft designer, R. J. Mitchell, who was responsible for the production of all the Schneider Trophy planes that won the trophy three times in succession for Great Britain. Their co-operation and interchange of ideas in the building of the Supermarine S.6.B. resulted in far more than the winning of an air speed record. It led directly, through a line of high-speed fighter planes, to the development of the " Spitfire " fighter powered by a Rolls-Royce " Merlin " engine—perhaps the best known fighter plane the war has produced.

The prototype of the " Spitfire " was not built, however, until 1936. Three years earlier an engine known then as the P.V.12 had taken shape on the drawing boards of the Rolls-Royce engineers. This engine, later to be known as the " Merlin," was derived directly from the " R " engine of the Supermarine S.6.B. Basically the same type as the " Eagle," yet different in hundreds of details, the " R " engine was Royce's finest achievement.

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As he looked it over, a wonder of shining aluminium and polished steel, he must have smiled to think that to drive its supercharger alone required all the 360 h.p. that was produced by his original "Eagle" engine at the height of its development little more than a dozen years before. When he died in 1933 he was not to know that the engines he designed were, at one time or another, to hold every absolute speed record—407·5 m.p.h. in the air in 1931; 130·86 m.p.h. on water in 1937; 357·5 m.p.h. on land in 1937. Nor was he to know that engines developed from his Schneider Trophy design were to power the fighter planes that won probably the most important air battle of all time.

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"MERLIN"

The triumph of the tradition

A MODERN HIGH-OUTPUT aero-engine is at once the most compact and versatile power plant that has ever been devised. And it is probable that an engineer is called upon to satisfy a greater number of limiting conditions, and solve a greater number of engineering problems in designing it, than is the case in the designing of any other type of power unit. Here are some of the conditions under which an aero-engine must function efficiently.

It must be capable of working in any position, for it must not falter when the machine in which it is installed is climbed, dived, rolled, banked, or even flown upside down. The pilot's life may depend upon its responsiveness during complicated aerobatics and fighting manœuvres. At modern flying speeds a tight turn can set up forces that could so seriously affect the flow of fuel that the engine would cut out if these factors are not taken care of in design. It must not fade or cut out during rapid changes of altitude and temperature, as well as direction. On a sweltering summer's day it must work efficiently at a ground temperature of 90 degrees and still function at the end of a seven-mile climb where the temperature will be down to 100 degrees of frost. It must work efficiently in widely diverse climatic conditions, including the tropical heat of North Africa, the humidity of the Burmese jungle and the arctic cold of

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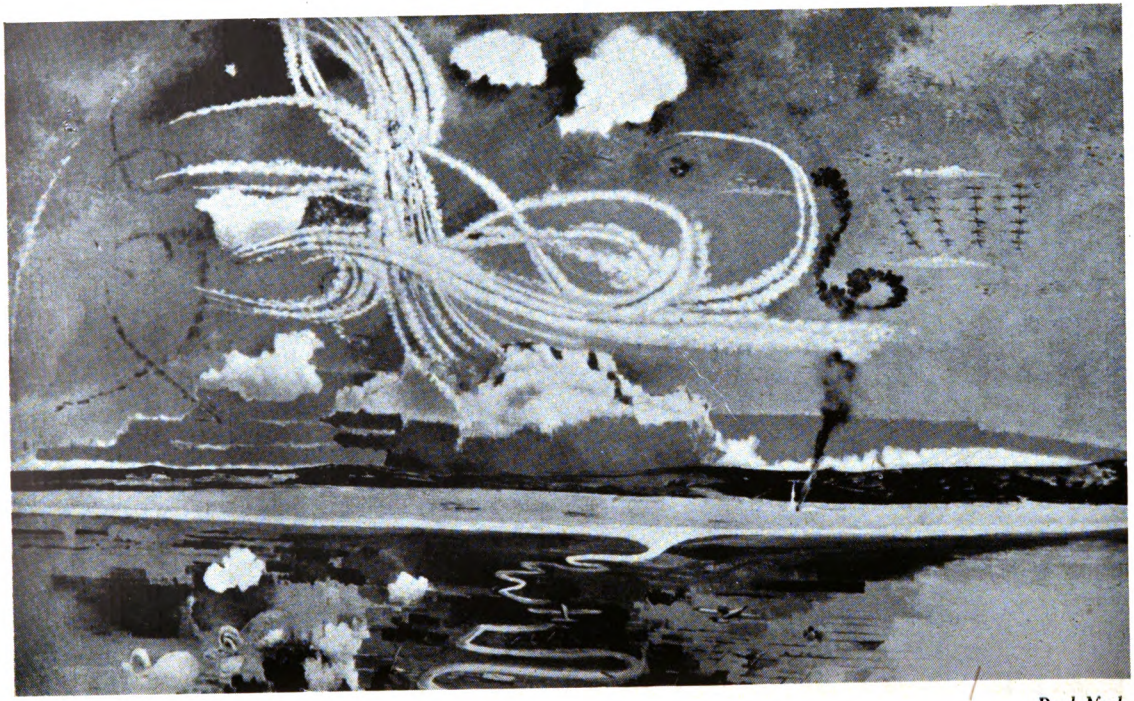

"BATTLE OF BRITAIN" *Paul Nash*

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Northern Russia. It must give full power at heights where the air is so rarefied that special arrangements have to be made to pump additional air into the induction system. Here it should be pointed out that the main factor determining the power of an internal combustion engine is the amount of air, in combination with petrol in the correct proportion, that it is capable of consuming. At a height of four miles the air is so rarefied that an engine with no compensating devices could consume so little air that it would develop less than half its power at ground level. The compensating device used by the aero engineer is the supercharger. In the layman's mind the supercharger is usually associated with the production of extra power from a racing car engine. This is a secondary consideration when it is fitted to an aero-engine—its main object is to compensate for the gradually decreasing air density as the aircraft climbs. This must be done automatically so that the pilot does not have to worry about controls.

But the aero-engine must do more than deliver the power necessary to fly the aircraft at great speeds and heights. It must provide power to drive auxiliary units such as air compressors for gun-turret operation, hydraulic pumps for retractable undercarriage and bomb doors, vacuum pumps and the constant-speed airscrew operating pump, and a dynamo to keep the batteries sufficiently charged to offset the current consumed by the many electrically operated devices on the modern service aircraft.

With all these limiting factors in mind the designer must make his engine as small as possible so that it offers

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the minimum wind resistance. And though he is bound to build it as light as the materials available will allow, it must be capable of standing terrific stress under normal working conditions. The valves, for instance, must work at 850 degrees C. and the impeller in the supercharger must work at speeds up to 30,000 revolutions a minute.

Even when all these problems have been solved satisfactorily the engineer's ingenuity is further taxed by such unpleasant phenomena as the aeration of fuel at high altitudes and lubrication difficulties due to changing atmospheric pressures. He must arrange for effective flame dampening of exhaust systems so that the aircraft's position is not given away at night. Finally, his complicated piece of machinery—there are 11,000 separate parts in a " Merlin," 2,500 of which are different—must be utterly reliable, need the minimum of service attention and give the maximum of flying hours before overhaul is necessary.

These are some of the difficulties the aero-engine designer must overcome, some of the problems he must solve. The " Merlin " engine, then—this assembly of 11,000 carefully machined and fitted parts of alloy aluminium, brass, bronze and alloy steels—is something more than a beautifully designed and wonderfully efficient aero-engine. It is the answer to a complex of problems that have demanded for their solution the concentrated energies of one of the finest teams of designers, research engineers, and metallurgists that exist in Britain. And in the " Merlin " they have carried the achievement of their great founder to a point that even he could hardly have imagined to be possible.

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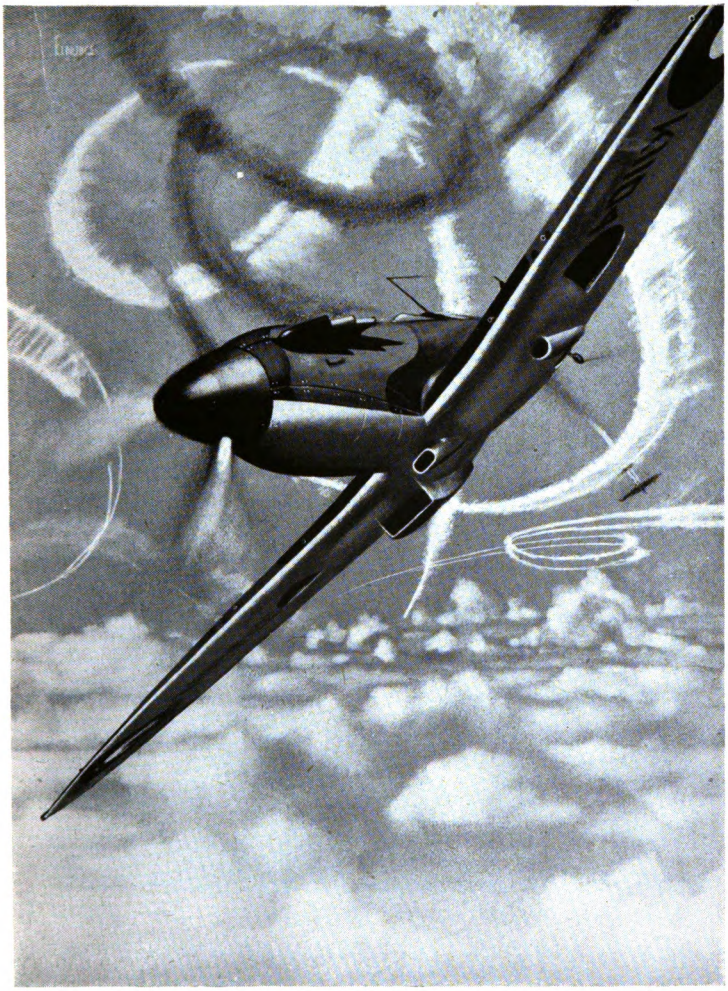

SPITFIRE : "VICTORY ABOVE THE CLOUDS" *2nd Lt. Eldridge*

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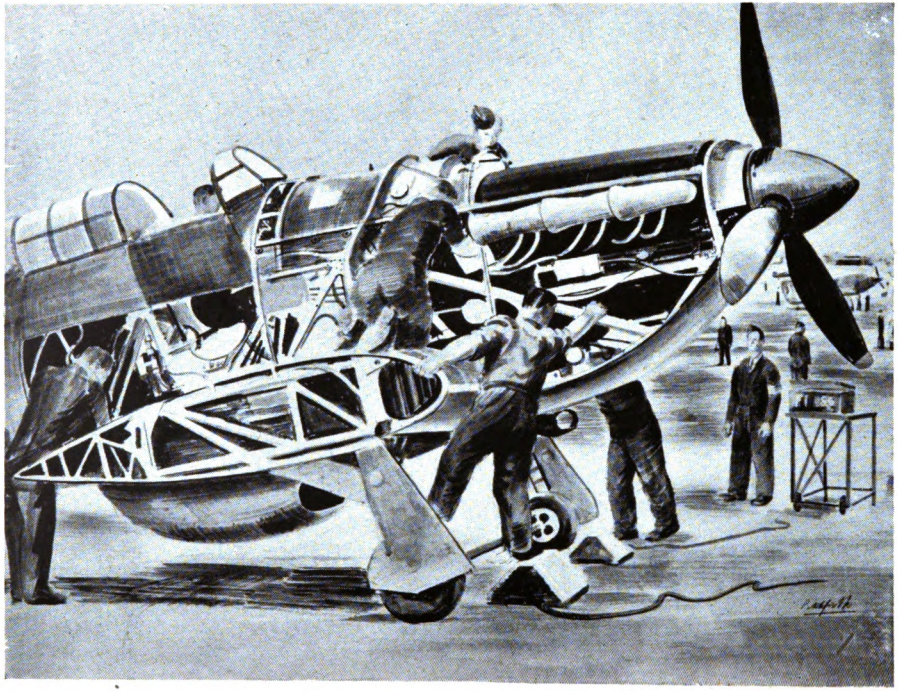

" HURRICANE ON TEST "

R. V. Pitchforth, A.R.A.

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Those who take more than the usual interest in technicalities will want to know something of the outstanding features of its design.

It is a twelve-cylinder liquid-cooled supercharged engine. The twelve cylinders are arranged in two banks of six mounted on the crankcase in " V " formation, the angle between the " V " being 60 degrees. Four valves per cylinder, two inlet and two exhaust, are operated by overhead camshaft through the medium of rockers. One camshaft, carried in seven forged aluminium bearings, is used for each cylinder block. The exhaust valve stems are hollow and filled with sodium to assist cooling. A balanced, hollow crankshaft, carried in seven main bearings of special lead-bronze, transmits the drive to the airscrew. Connecting rods are of " H " section steel forgings. The aluminium pistons are provided with three pressure and two scraper rings. The pistons work in high quality steel liners inserted in the cast aluminium cylinder blocks. A centrifugal-type two-stage supercharger driven by a special two-speed gear mechanism delivers the mixture at above atmospheric pressures. Each cylinder is fitted with two sparking plugs served by two separate twelve-cylinder magnetos so that the complete ignition system is duplicated. One carburettor of twin-choke up-draught type is used. High-pressure, dry-sump lubrication delivers oil at pressure to crankshaft and camshaft bearings and all the bearings and gears throughout the mechanism. The coolant is a mixture of 70 per cent. water and 30 per cent. ethylene glycol circulated by centrifugal-type pump. The complete

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engine stands 3 ft. 5 in. high, 2 ft. 5 in. wide, and 7 ft. 3 in. long—it takes up no more than the space of a single bed. At the time of this writing it is only possible to reveal the performance figures for an early type of " Merlin " which gives a maximum power output when the low supercharger gear is used of 1,260 h.p. at 12,250 ft. altitude ; maximum output with the high gear ratio is 1,175 h.p. at 21,000 ft. The engine weighs 1,450 lb.—something over half a ton. It produces more horse-power per pound weight than any other similar engine in the world. These figures, of course, are now greatly exceeded by improved types in immediate production and scheduled for future production. It can now be revealed, for instance, that the Rolls-Royce " Griffon "—a development from the " Merlin "—has a capacity of 36·7 litres against the 27 litres of the " Merlin," and in this respect is the same size as the Schneider Trophy " R " engine. For security reasons, information may not yet be given as to the full horse-power developed by the " Griffon," but it can be said that it is considerably over 2,000 horse-power, giving the engine a power-to-weight ratio of less than 1 lb. per horse-power. Many of the " Merlin's " most advanced features—such as salt-cooled valves, balanced crankshaft, air intake, bearing types and supercharger design—it has inherited from its direct prototype, the Schneider Trophy racing engine which has won for Britain every absolute record on land, water and in the air. Into the " Merlin " itself has gone over ten years' intensive research work, five of them under the operational condition of modern warfare. It has been produced in

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greater quantities than any other single operational type built in the history of British aviation.

It was the only engine used in the fighter planes that defeated the Luftwaffe during the Battle of Britain. It is the power behind the wings of the following world-famous British aircraft—the " Hurricane," " Spitfire " and " Seafire " fighters, the " Mosquito " fighter-bomber, the " Lancaster," " Halifax," " Wellington " and " Whitley " bombers, and the " York " passenger and transport plane. The Rolls-Royce " Merlin " engine is now made in America, as well as Britain, and is also fitted to the American-built " Mustang " fighter, used to escort American heavy bombers in their daylight attacks on Berlin.

That is the design, that is the power output, and that is the record of the Rolls-Royce " Merlin." It has never failed in performance to keep that slight edge of superiority over all Axis types that contributes so much to success in air warfare. It is probably the most reliable high-output aero-engine in the world. It certainly must be considered one of the supreme achievements of British engineering skill and craftsmanship. The production of such an engine goes far to explain why Britain could not be defeated in the air by Göring's mass assault in 1940.

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" There is no sure way of judging anything except by experiment "

OVER SIXTY YEARS have passed since the founder of the Rolls-Royce tradition first learnt the art of handling a file with a sureness and deftness of touch that can turn this simplest of engineer's tools into a precision instrument. Advances in technology over that period have been more rapid than at any time in the world's history. The technique of mass production from a prototype has been raised to an exact science. Machine tools of unerring accuracy have replaced the craftsman mechanic. Statistical principles are invoked to control the flow of production and even to check the quality of workmanship. The accuracy of the machine tool jigs is checked by finely calibrated gauges. And even the gauges themselves must satisfy the regular scrutiny of the toolmaker using electrical measuring devices that can register a deviation of one-millionth of an inch. The production in quantities of a high-output engine such as the " Merlin " demands almost inhuman efficiency in the tool room, the testing bays, the experimental shop, and on the assembly line.

In the standards room at the Rolls-Royce factory a " hair's breadth " is a measurable, significant distance. Behind double doors the temperature and humidity of the air are kept constant by air conditioning. Compared with the tool room it has almost the surgical cleanliness of an operating theatre. Under shadowless lighting,

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electrically operated measuring machines give readings of one-hundred-thousandth of an inch. One surface-testing machine—the Profilometer—is eyed with a certain amount of apprehension by even the most skilled toolmakers. Looking something like a seismograph, it transfers the contour of a surface to a chart on a rotating drum. The toolmaker's most finely made gauges, patiently "lapped" and polished, show startling peaks and valleys under its inquisitive needle. A mirror-like bearing surface, machined to one-ten-thousandth of an inch, can yield a contour graph with the ups and downs of a hospital patient's temperature chart.

In the metallurgical laboratory now R.R. alloys for special purposes are continually being developed. Components can be fabricated in translucent plastics and the actual effect of stresses can be photographed just as they might occur under working conditions. The effect of one stress can be shown isolated or superimposed on others.

In the chemistry laboratory, research is carried on into the nature of corrosion, the effect of electro-plating, the annealing and pickling of metals, the qualities of oils and coolants, the behaviour of materials under every conceivable circumstance and climatic condition. Analysis of raw material is always in progress to confirm the results of metallurgical testing.

Raw material testing is taken to the stage where every bar and forging must undergo scrutiny. Tensile strength, hardness, impact and fracture tests are applied in conjunction with heat treatment. The behaviour and condition of every alloy or metal used are photographed,

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recorded, charted, indexed—almost with the thoroughness of a patient undergoing a clinical examination.

Routine inspection during production includes microscopic examination and X-ray photographs. The radiologist may examine as many as 300 plates of sample castings in one day—and even a slight flaw may mean that the whole batch from which the sample is taken will go back into the furnace.

To test and check, and re-test and re-check, at every stage of production is routine procedure in engineering practice. And working to exceptionally close limits and fine tolerances has been made possible by continually improving methods and machine tools. But meticulous care in testing, and working to even closer limits than would appear necessary, have always been a part of the Rolls-Royce tradition. It was the great engineer's secret of maintaining repetition work at standards usually expected only of the experimental workshop. He knew that it was not enough to design a good aero-engine. Workshop practice had to be organised and adapted to produce it in quantities. So when the " Merlin " went into production a finely tempered organisation already existed—trained and ready to build it. For Rolls-Royce can draw upon nearly forty years' experience of making internal combustion engines, and twenty-seven years of making aero-engines.

The stage which technology has reached in a modern factory might suggest that the day of the individual designer and the individual craftsman is over. It would be too hasty an assumption. Certainly, at Rolls-Royce,

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design and experiment are now in the hands of a highly qualified team trained in the tradition. And it is probably true that no one man will ever again exert so powerful an influence on a great organisation. But the day has not yet been reached when an engine such as the " Merlin " can come into existence simply through calculations made at the drawing board and quantity analysis carried out in the office of the production engineer. True, the human element is being reduced to a minimum in the machine shops. But it is very much in evidence in the planning, experimental and research departments.

In the quiet rooms of a country house, with windows overlooking lawns that slope down to a meandering river, the present-day planning and design staff work, as did Henry Royce, far from the noise and clatter of the factory. Undisturbed by departmental responsibilities or administrative duties, this highly skilled team is free to concentrate its whole energies on improvements to existing engine types and future projects. Their research and development programme, as well as dealing with immediate modifications, embraces engine types that are not likely to be in use for another ten years. They work closely with a staff of model makers who can quickly give three-dimensional form to basic schemes through the medium of small and full-scale wooden models. An examination of these wooden " mock-ups " as they are called may suggest alterations which can then be embodied at an early stage. The basic schemes are then passed to the design office where design drawings proper of the modifications are made. From here the designs are handed to the detail

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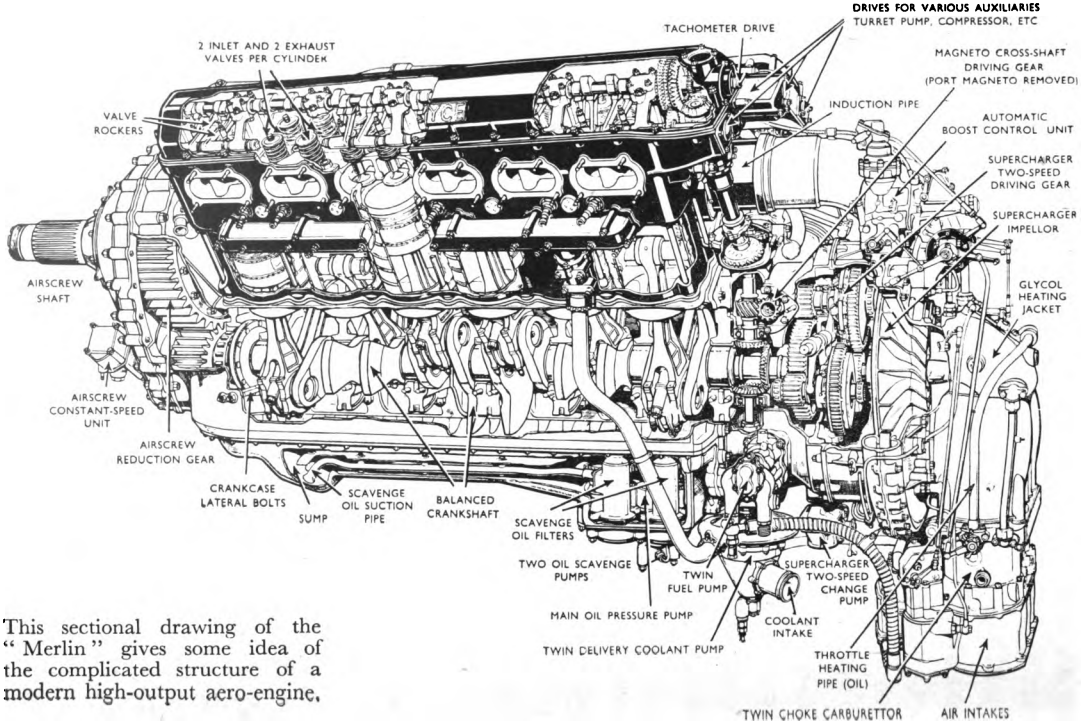

This sectional drawing of the "Merlin" gives some idea of the complicated structure of a modern high-output aero-engine.

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drawing office, where they are converted into drawings of every individual piece, giving full information on all dimensions, permissible manufacturing tolerances and particulars of materials to be used. These drawings, when photographed, become the blue-prints from which the actual parts are made in the experimental workshops.

The Rolls-Royce engine and power plant design and detail drawing offices employ a staff of over 500 skilled men. It is a large number compared with the modest staff controlled by Royce when he was designing the first Rolls-Royce aero-engine. But the example of the great engineer still serves as an inspiration to the planning and design organisation of to-day. Faced, as Royce was faced, with the challenge of an enemy who can draw upon tremendous reserves of technical skill and ingenuity, Rolls-Royce engineers in this war have usually succeeded, as he succeeded, in keeping engine performance ahead of the best the enemy could achieve.

In the early days of the war German fighters appeared to have a slight advantage at high altitudes due mainly to the lighter overall weight of their aircraft. But at the outbreak of war Rolls-Royce engineers were well aware that it was necessary to go on increasing power output, and within two months schemes were quickly developed to incorporate a larger carburettor and supercharger intake on the " Merlin." These were designed so that the minimum of alteration was required to the production aircraft in which the modified engine was installed. This improvement enabled British fighters to retain their superiority at high altitudes nearly a year later in the

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Battle of Britain. It gave British fighters an edge in performance over their German counterparts for a considerable time—for modifications to a high-output aero-engine, even under stress of war, must take time to reach the production line.

But it was certain that a resolute enemy would make every effort to gain an advantage which might prove decisive in the air war. So the planning and design organisation, working in shifts day and night, produced the two-stage supercharger with intercooler. The planning, design and development work necessary for this modification was probably more intensive than anything previously achieved by the company. Within twelve months of the original planning investigation an experimental engine was running on the test bench ; within eighteen months the first production engine was delivered. This was certainly a technical and production achievement of a very high order. A comparison of the performance figures of the two-stage engine with the single-stage " Merlin " gives a measure of the progress made in so short a time. At an altitude of 20,000 ft. the horse-power of the two-stage " Merlin " is 50 per cent. greater than on earlier types, while its full throttle brake-horse-power is actually double that obtained from the " Merlin " in use at the outbreak of war. In the battle that is fought on the drawing boards, Rolls-Royce engineers had the better of another brisk skirmish with the enemy. For their " Merlin 61," with the two-stage supercharger and intercooler, was in service in the " Spitfire " in good time to meet Germany's newest and best fighter, the F.W. 190.

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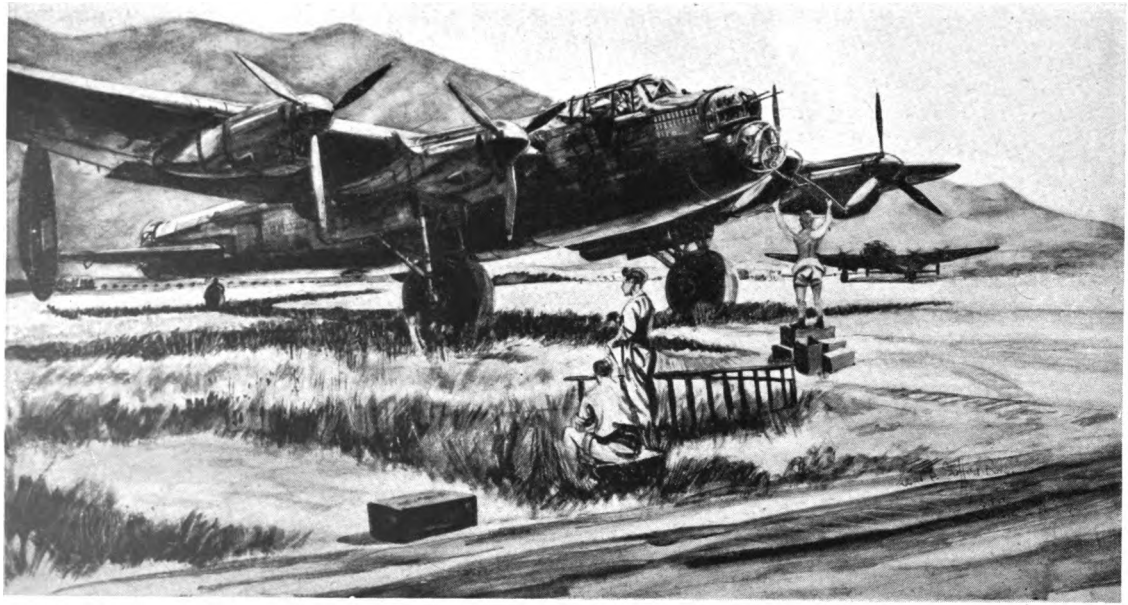

"LANCASTER IN NORTH AFRICA"

Julius Stafford Baker

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"YORK" four-engined transport

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Royce had repeatedly insisted : " There is no sure way of judging anything except by experiment." It is certain that he owed as much to the thoroughness and patience of his experimental work as to the soundness of his original design. So in the Rolls-Royce organisation thorough research and satisfactory experimental results are the basis of every production modification that originates in the planning and design department. In the experimental shops 1,400 men, every one able to set his machine and read the most complicated drawing, are employed night and day purely on experimental work. Engines complete in every detail are built in this shop, run on the test benches, stripped, examined and re-erected. It is like a compact little factory on its own, staffed entirely by men who would occupy the highest engineering grade in the production shops. It is like a factory—but there are subtle differences. Rows of machine tools glint under the mercury vapour lamps—but at each one a skilled engineer is at work. Little electric trucks trundle around—but they carry perhaps one or two components instead of the mounting piles that pour from the production lines. Work seems unhurried, more deliberate. Beside nearly every machine stands a little stack of blue-prints mounted on stiff cardboard. Here an electric drilling machine sinks its steel fangs almost silently into a grey casting. There, under a milky white stream of coolant, little slivers of metal curl and twist away from the cutting tool of a turret lathe. But some machines stand motionless while the operators pore over a drawing ; elsewhere a grey-headed designer

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in his neat blue suit peers speculatively at a component held in the blunt fingers of an overalled fitter. Engines, in every stage of completion, stand around on their steel cradles. On huge tables other engines have been completely stripped down and laid out for inspection after a running test. Parts are as neatly arranged and ticketed as specimens in a museum. Around the tables walk the inspectors, stooping over the exhibits with a student-like earnestness of scrutiny. Microscopic examination reveals minute flaws that have developed. X-ray photographs probe the inner secrets of forgings and castings. A complete history of an engine's performance and behaviour is compiled for the designer and metallurgist—a sort of clinical case history sent through from the general practitioner at the patient's bedside for the expert diagnosis of the specialist in his laboratory.

One of these stripped engines, in its completed form, has probably run for a hundred hours in one of the thirty-odd testing houses attached to the experimental shops. Here they roar away continuously while shift succeeds shift at the engineer's control panel. Progress is reported by flickering needles on twenty different dials and by the movement of columns of liquid in long glass tubes. Hour by hour the log of its performance is entered up—coolant temperature and suction, oil temperatures and pressure, petrol pressure to the carburettor, boost pressure from supercharger to engine, petrol consumption, revolutions per minute, and power delivered in brake-horse-power. For over ten years the behaviour of the " Merlin " under every conceivable modification has been

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watched and charted in these test houses. For over ten years the story told by worn or broken parts on the examination benches has been passed on to the designers and metallurgists. For over ten years the lessons learned have been progressively incorporated in new engines built in the experimental shops.

Development work based on knowledge gained from the bench performances alone would not satisfy Rolls-Royce engineers. For in considering the engine as a part of a complete functional design—the fully equipped aircraft itself—a new set of problems arises. So a full-scale flight development programme has been carried out over many years by the Rolls-Royce installation department. Here a highly trained team of test pilots spends every possible flying hour testing the engines in the prototype machines. A vast amount of valuable technical data has been accumulated as the result of thousands of hours of test flights. In the flight hangars attached to the aerodrome completely equipped assembly shops are maintained for the rapid installation of experimental engines in aircraft. Expert designers specialise in the installation problems connected with each part of the power unit—the induction, fuel, cooling, and oiling systems. Each designer has his own research bay and works with his own highly trained team of experimental engineers.

Even such thorough and continuous flight testing does not tell Rolls-Royce engineers all they want to know about the "Merlin." So over two hundred trained maintenance men are attached to R.A.F. operational

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stations, observing and reporting on the engines under operational flying conditions.

The " Merlin," then, is the outcome of many years of planning, research and experimental work. Its design, established long before the war, was based on the work of Henry Royce—perhaps the greatest of all aero-engine designers in the history of British aviation. But its continued superiority, war year by war year, over every enemy type, has been maintained only by the brilliant improvisations and the inspired designing of Rolls-Royce engineers to-day. And though the " Merlin," and its immediate successor the " Griffon," represent the triumph of an engineering tradition, they will certainly be replaced by yet better engines. For the tradition admits of no finality, either of design or in standards of workmanship. And in the production of yet better engines the work of Rolls-Royce engineers will make its contribution to the future technological development of not only Britain's, but the world's, aircraft industry.

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THE BUILDING OF A "MERLIN" AERO-ENGINE

THE PRODUCTION of a high-output aero-engine in quantities from raw material to the finished product makes the severest demands on the production engineer. Each of the eleven thousand parts in a " Merlin " must be made in planned and ordered sequence. Thousands of engineering operations must be synchronised to keep production flowing smoothly toward the test benches. The complications of the task can be better understood when it is known that one part—the crankshaft—requires over one hundred machining operations before it is ready for assembly.

Planning production in the factory. Each white cut-out on the table is a true-to-scale model of a machine tool.

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Casting the light alloys. Two cwt. of molten aluminium is emptied into a cylinder-head mould with a " two-handed pour."

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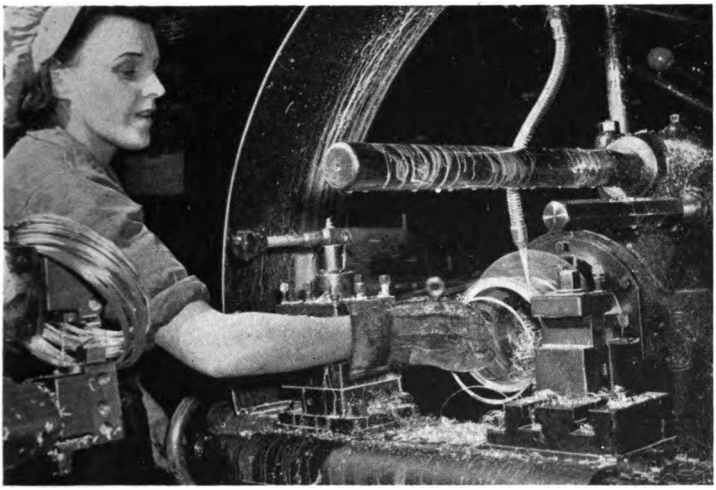
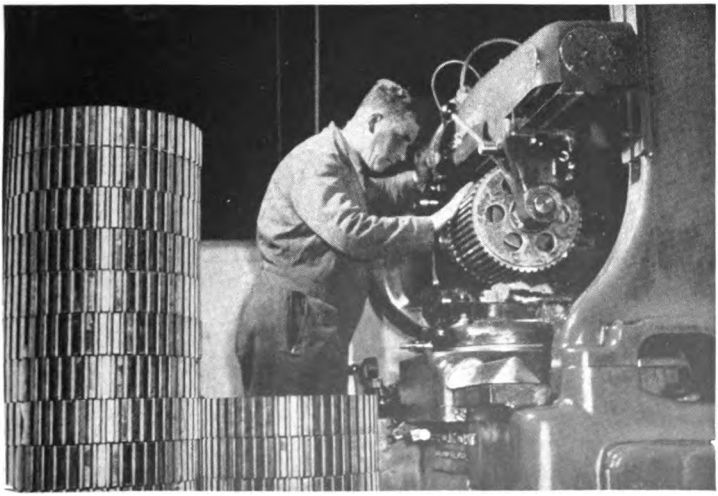


Machining sealing rings. If an error of one-thousandth of an inch were made the completed engine would seize up.



Gleaming piles of gear wheels. At the machine a semi-finished cut is being put on to the teeth.

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The "Merlin" is built in a mechanical wonderland. Here a vertical driller sinks its steel teeth into a casting.

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Chalk testing of an aluminium casting to detect the slightest flaw or crack. Only perfect castings are used for the " Merlin."

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X-ray photographs are used to test sample castings. This negative reveals evidence of oxide inclusions. The casting will be rejected.

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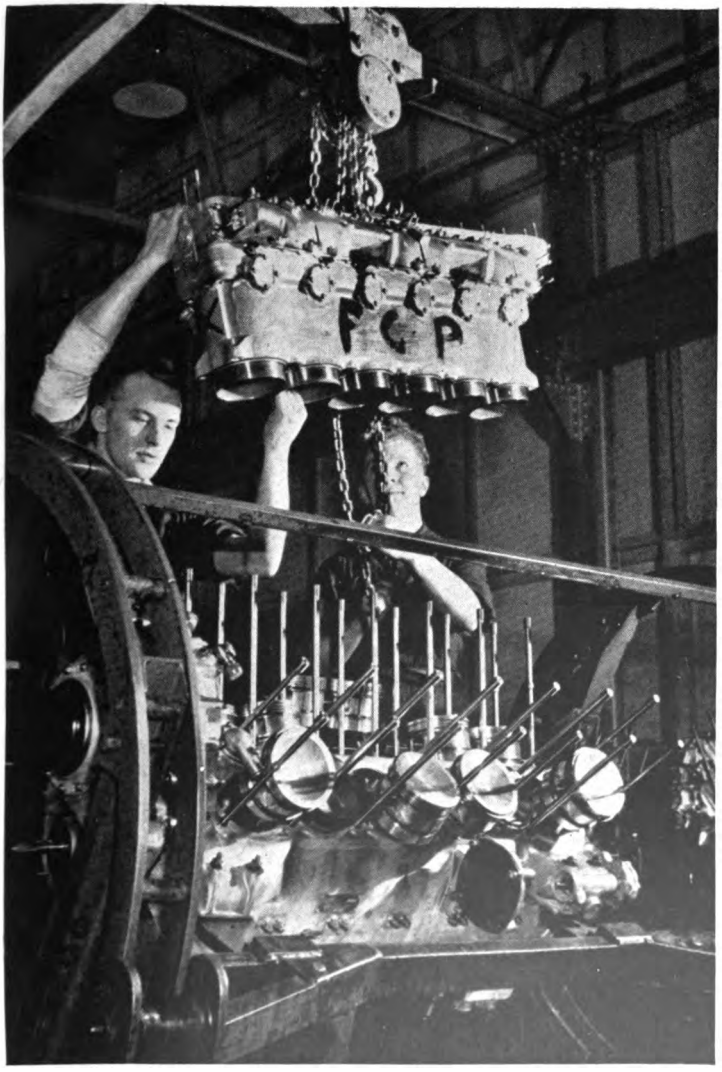

The engine nears completion. Here the cylinder-block of one bank is being lowered into position for mounting.

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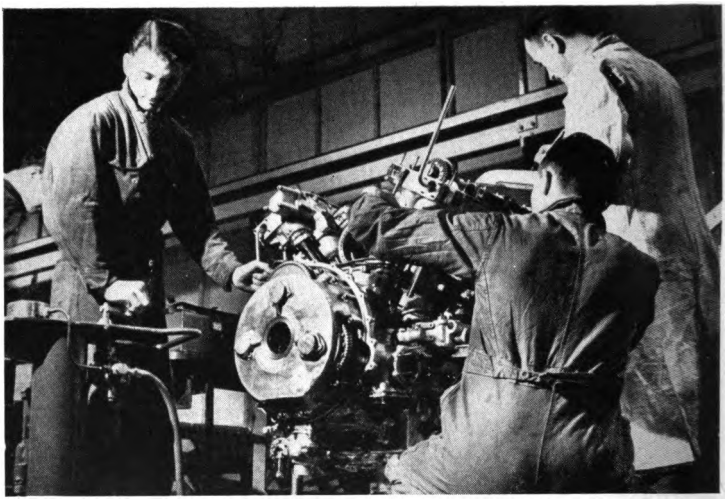

An operator oil-tests the camshaft while a white-coated inspector checks the flow of oil through the rocker.

Over twenty dials on the engineer's control panel record every aspect of the engine's performance while it is on its final test.

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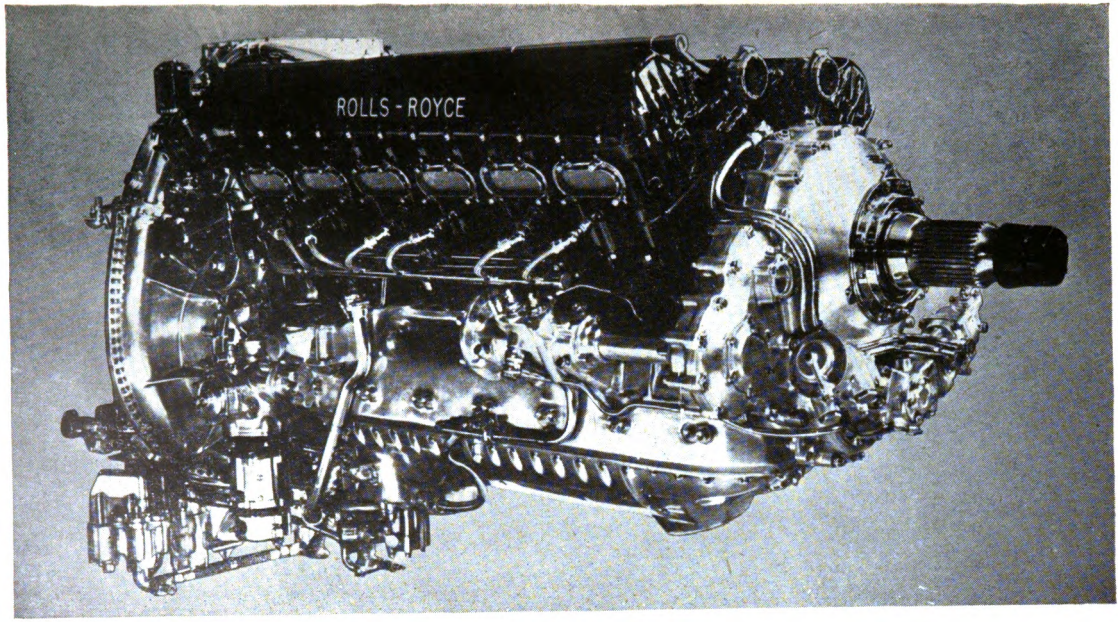

" The 'Merlin' engine . . . this assembly of 11,000 carefully machined and fitted parts of alloy aluminium, brass, bronze and alloy steels, is something more than a beautifully designed and wonderfully efficient aero-engine. It is the answer to a complex of problems that have demanded for their solution the concentrated energies of one of the finest teams of designers, research engineers and metallurgists in Britain."

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"There is no sure way
of judging anything except by experiment."

SIR HENRY ROYCE

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DEFENSE

Wise eating in wartime

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WISE EATING IN WARTIME contains fifteen broadcast talks, on wartime diet for adults, given by Dr. Charles Hill. "The Radio Doctor," as he is known to millions of listeners, tells us how we can make the most of our rations, and keep our bodies tuned up to concert pitch by eating sensible, balanced meals. He takes us behind the scenes, showing the part played by various kinds of simple food in strengthening, warming, and refreshing the inner man. Everyone, from the housewife catering for a family, to the bachelor eating alone, will profit from Dr. Hill's cheerful and practical advice.

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Wise eating in wartime

prepared for the Ministry of Food
by the Ministry of Information

HIS MAJESTY'S STATIONERY OFFICE : LONDON : 1943

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Acknowledgment is due to Hilaire Belloc and to Messrs. Duckworth and Co. Ltd. for permission to quote ten lines of Mr. Belloc's poem "On Food", from *Cautionary Tales.*

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1. *A little of what you fancy*

To-day we are interested in food as never before. It's taken a war to make us interested, but that's by the way. In this little book I want to talk about some of the commoner dishes that turn up on our tables. But before I do that I want to remind you that you can eat the right foods in the right amounts of calories and proteins and what-not—you can run through the whole alphabet of vitamins—and still lack something important. That something of importance is *variety*.

Scientifically speaking, you could live only on milk and potatoes and cheese and something green and raw, and be healthy. As a matter of fact you would be bored to death and your digestion would suffer. Repetition day after day of the same foods, cooked and dished in the same way, is enough to drive a man to drink—and it sometimes does. I can speak feelingly on this. I liked Lancashire hot-pot, and I said so. But then it began to appear every Thursday as regular as clockwork. I don't like hot-pot nearly as much as I did. Bring a child up on rice pudding and in later life he'll loathe it. Familiarity has bred contempt, or something worse. Why is this?

First, a man's digestion is influenced by his state of mind. Monotony means poor digestion. Worry, too, may lead to indigestion, sometimes serious indigestion. Food for which you have an appetite is food that you digest better because of that appetite. And variety inspires appetite. A little of what you fancy does you good, because you fancy it, because you have an appetite for it; or because, having an appetite for it, you pour on it more digestive juice and digest it better. That's why foods which aren't essential foods—like sweets, or "afters," and cakes—have *some* place in our diet. They ring the changes. Another danger to digestion is worrying too much about what happens to the food inside you. I think

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it was Mark Twain who said that part of the secret of success in life is to eat what you like and let the food fight it out inside. That's half the truth.

Let your diet be scientifically sound and varied so that it tickles the appetite—and forget it when it's inside you. But remember that a diet which doesn't contain builders won't become a building meal simply because it's served by a pretty waitress. Food without vitamin C won't save you from scurvy simply because you're as hungry as a hunter.

The secret is to learn to fancy the right foods. But this is easier said than done. What stands in the way? Well, first there's tradition, national tradition. It's not necessarily wrong, but when it's wrong it's difficult to move. Take for example the British habit of the Sunday joint. Hot on Sunday —cold on Monday—and if there's anything left, hashed or murdered on Tuesday. At least that was the pre-war routine in most of our households. Bang goes ingenuity and variety for the first three days of the week. Well, the war is damaging the Sunday joint tradition. And the Ministry of Food's education campaign is telling us of a thousand and one ways in which we can serve up the smaller bits, the odd bits of meat, attractively.

Secondly, there's use and habit. The wife has learnt to cook a few dishes and is content with them. She doesn't read the cookery book or the cookery articles. Someone has worked out that less than a quarter of this country's housewives use cookery books or read cookery articles. Mrs. Beeton's, rather like St. Paul's Cathedral, is known by everyone and visited by few. There's room for great improvement here.

I know that as a result of the war more and more people are eating out. But the vast majority of us still take most of our meals at home. We can't change our wives but they can change their ways, at least in giving their victims greater variety in their victuals. For variety means appetite—appetite means digestive juice—digestive juice means digestion—and good digestion means good absorption, and that's what we want.

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That Sunday joint

In the last chapter I was a little bit rude to the Sunday joint, blaming it for some of the monotony of English feeding—hot on Sunday, cold on Monday, and so on. I want now to probe a little more deeply the mysteries of that Sunday joint. We, in this country, aren't the biggest meat-eaters in the world. We come fourth, with New Zealand heading the list. Beef is our favourite. Before the war we ate more beef than pig meat, and more pig meat than mutton and lamb. But, of course, pig meat includes not only pork but bacon.

Here are a few figures. The poorest of us before the war spent about 1/1 per head per week on meat: 5½d. on beef, 4d. on pig meat and 3d. on mutton and lamb. The richest of us, those getting over £1,000 a year, spent 3/5 a head on meat. The great majority—those of us who are neither rich nor poor but manage to rub along—spent 1/7 per head per week on meat. This gives us some idea of the reduction the war has meant—Not much is it? No, it isn't very much even if we bear in mind that the ration for children is half the 1/2 allowed for adults. These figures show that, as we pass up the income scale, so the amount spent on meat increases. It's not necessary, but meat, of course, is a tasty and appetising food. Over and above a certain amount, meat's a luxury.

Now for a word about its virtues. Here are a few points:—

(1) The edible part of meat is its muscle. Tender meat is mainly muscle with very little tissue in between—mainly muscle fibres. But the older the animal, the more it has worked, the more tissue in between—in other words, the tougher the meat. The woodcock is mainly a flier, the partridge is mainly a walker. Hence the doggerel—"If the partridge had but the woodcock's thigh he'd be the best bird that e'er doth fly."

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(2) The younger the meat the more water in the muscle fibres. "Calf meat is half meat," as someone once said.

(3) Freshly killed meat is tough, the *rigor mortis*—the death stiffness—is still there. Hang it, and the *rigor* passes off; and the meat becomes a little acid. This acidity gives it a good flavour. That's why the flesh of hunted meat has a good flavour—from the acid due to the muscular exertion immediately before death. Soaking meat in vinegar for a short time improves its flavour by making it acid.

(4) The taste of meat is due, not to its protein—its building bricks—but to its extractives. The more mature the animal, the more its extractives and the better its flavour. But its food may influence its flavour. Wild duck is tastier than a farmyard duck. Mountain-fed mutton is better flavoured than turnip-fed mutton.

(5) What does cooking do? It loosens the fibres; it melts some fat and it evaporates some water. It makes the flesh more appetising. Lightly cooked meat is digestible; and overcooked meat isn't. Housewives please note.

Mutton is more easily digested than beef, and beef than pork. But under pork I don't include bacon. Bacon's very digestible, even by the youngest children. Breast of chicken is among the most digestible foods. Oh, shades of the past! Anyway, most of us can digest most meats most of the time. Lastly, the absorption of meat. Practically all its goodness is absorbed, and quickly. It's a well digested food.

Meat is supposed to arouse animal passions. This is nonsense. Eskimos live mainly on seals and fish and game and eggs, and they're the most peaceful people in the world. Some vegetarians, on the other hand, are not so peaceful! What price Hitler? By the way, horse flesh is a good builder, though I've never tasted it. Our cat likes it anyway. But meat is a dear food, if a tasty one. As I have said before, meat's not essential. We need a certain minimum of builders, but they can be got just as well from milk or cheese or fish or eggs; good second-best builders are the pulses—beans and peas and lentils.

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Offal good value for money

Yes, it's about offal and I promise not to make any more puns. I know it's often difficult to get, though it's been a bit more plentiful lately. But I'll tell you something of its virtues in case you can get a bit now and then.

Offal is about a third of the total weight of the animal. Under this heading we include kidneys, liver, sweetbreads, blood, heart, lungs, brains and tripe. By the way, whenever I mention tripe on the radio I usually get at least one letter in which the word "tripe" is given quite a different meaning. But let that pass. Taking offal by and large, it's good value for money.

First, liver and kidneys. They are very solid organs stuffed full of food. For this reason they are sometimes difficult to digest unless they have been minced or, better still, well chewed. They are mainly building bricks of protein along with a little fat. There's only one snag. There's something in their protein which goes to make uric acid, the cause of grandfather's gout. So if you've a tendency to gout, lay off liver and kidneys. If you haven't, they're the goods.

The heart is a close-knit sort of organ: but if it is well chewed, most people can easily digest it. It's grand food—and what's nicer than a stuffed sheep's-heart? At first sight you might think that blood is a good food, even though you might not fancy it. As a matter of fact it isn't. It's four-fifths water—so blood's not much thicker than water after all. It's all right in black puddings, if you like black puddings, but it's nothing to write home about as a food. The same with lungs, or "lights" as the butchers call them. They're mainly wind, and goodness knows there's enough wind in our diet nowadays.

The term "sweetbread" covers two organs. It may be the thymus gland of the calf. That's a gland that's present in

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the human being in the early days but which shrivels up as we grow older. The other sweetbread is the pancreas. Now both of these kinds of sweetbread are among the most digestible animal foods we know. And they're good food except for the gouty. To him they are murder. At least to his big toe.

Now for the tripe, that tasty morsel of the North. No, the comedians are wrong. It's not liver struck by lightning or even boiled knitting. It's the stomach and intestine of the ox made clean and sweet by boiling. It's easily digested, though it hasn't much flavour. It's a bit pappy. But what's the tripe without the onions? Those who like it love it. Those who don't, won't touch it with a barge-pole.

Now for brains. They're rich in fat and in phosphorus, so necessary for bone. But oddly enough, they're not easily absorbed in the intestine, nearly half of them passing through and out at the other end. Apart from this, they are good food. But to eat brains isn't to grow brains or we could all belong to the Brains Trust, given the right diet.

Fat fish and lean fish

Even in peace-time we weren't big fish-eaters in this country. For many people, fish hasn't enough flavour. They prefer their chops and steaks and roast beef—"they're tastier," they say. But tastiness, like ripeness, isn't all. Fish should be regarded as meat—as fish meat. It's a good building food. We can't get all the fish we want, for obvious reasons, but it's as well to know what's in 'em, if only to know what we're missing.

Let's classify our sea fish. Group one is fat fish—herring, salmon, eels, sardines, mackerel and sprats. Fat fish have abundant building bricks of protein and a good deal of fat.

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Weight for weight, fat fish like salmon—and that includes tinned salmon—are as nourishing as meat. And don't forget the slippery eel.

Fat fish contain some lime and some phosphates—the bricks and mortar of bone, and the stuff you need for healthy blood. They contain some iron, without which you can neither bloom nor blush. They contain some iodine—particularly necessary for children and adolescents for keeping their thyroid glands normal. They contain some vitamins, particularly vitamin A—the one which protects the body from eye and other troubles, and vitamin D—the one which protects from rickets and helps to build strong teeth. Even the humble bloater is rich in these good things. Fat fish is the best fish.

Now for the lean fish, for example cod, haddock and whiting. They contain roughly the same foods, except that they have very little fat, and less vitamins. They're said to be more digestible than fat fish, though cod's on the coarse side. Dried cod is simply cod with its water removed, and it is stiff with building bricks of protein. Smoked fish, such as smoked haddock, is dietetically as good as fresh fish and is just as well digested and absorbed as meat itself. If you cook your lean fish in fat, the finished article is almost as fatty as fat fish. For example, whiting fried in batter has almost as much fat as herring baked in vinegar.

By the way, don't come over all superior at the mention of fried fish and chips. It's not only very tasty and very sweet—it's first-class grub. That's true whether it's dished up with dignity to the Duke in his dining-room, or scoffed by the nipper from a newspaper spread out on his knees.

Let me say three things about fish I've said before:—

(1) It isn't a brain food—there's no such thing.

(2) Fish loses practically nothing in food value by being canned or tinned or smoked. Let no one turn up his nose at tinned salmon.

(3) The herring is probably the best value for money of all building foods. Three herrings would give a man all the animal protein he needs for the day.

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Now for fish offal. You know the value of cod and halibut-liver oil in giving vitamins A and D, the ones that all growing children must have. Fish roe, both hard and soft, is good food. It has a bit of everything—a lot of vitamins and a lot of phosphates. It's excellent for children. The millionaire's caviare is only the roe of sturgeon plus a lot of salt. Crab and lobster —they're fair food value, but they're not too well digested. Oysters—well, they make your mouth water; they may slip down like jelly—but their food value is poor. With oysters at 7/6 a dozen, it would cost you £2/5/- a day to get your protein from them. But, of course, they're not eaten for their food value. Mussels, winkles, scallops, are all juicy, but their food value is poor.

A word about coarse river fish. A fisherman friend of mine —and, when he's not telling me of the weight of the fish he's caught, I believe him—tells me that they are good eating. And you've only to look at him to realise that he knows what's good eating. Perch—they're good despite the thick skin. A lot of Lakeland perch are now being canned. Pike, when they are less than 5 pounds in weight, are very tasty, particularly baked and stuffed. Gudgeon and chub aren't very good eaters. By the way, to get the muddy taste out of these river fish, cook with mint or soak overnight in a solution of salt.

Lastly, tiddlers—but there I'm drawing a red herring across the trail. And, speaking of herrings, remember they give you the best return of all for your money.

The world's best food

Milk has a place of its own, as the world's second best food. Number one is breast milk. But we can't go on with that after the first year. Cow's milk is a nearly complete food

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with its builders of protein, its fat, its sugar, its lime, its phosphates, its good supply of several vitamins. True, it is poor in iron, it is poor in some vitamins, it lacks another. But apart from breast milk there's no other food to touch it.

Let's see how much we drank in this country before the war. On average, counting in everybody, young and old, we drank about 3½ pints a week, or ½ pint a day. Children had more, of course, and grown-ups less, but that was the average. Switzerland drank 9 pints per head per week; the United States of America 6. We can't be said to have been a milk-drinking nation, though as a result of a publicity campaign the amount consumed was rising. But it was still far short of the 6 pints per week per head of the population which the experts say we should on average consume.

Almost all of these 3½ pints was being drunk at home, very little at restaurants and milk bars. Most of it was going into puddings. A lot was going in coffee in the case of richer people, and in cocoa in the case of poorer people. Then came custard and then breakfast cereals. But precious little was being drunk as liquid milk. What was wanted, then, was consumption of more and more milk as a drink. We have rather turned up our noses at milk. If we say that someone is a "milk-sop" we mean that he is weak and useless. If we talk of a "milk-and-water speech" we mean something pretty futile. The advertisements for beer may have led some people to think that it yields more strength than milk; that it's a man's drink; that milk is a little girl's drink. That's bunkum, of course. The strongest drink is milk. The war's an awkward time for increasing milk consumption, but a great deal is being done.

The Milk in Schools Scheme was here before the war. To-day getting on for 80 per cent. of our school children are drinking one-third of a pint of milk every day at school. But despite the fact that it's half price, or free if they can't afford it, there are still a few mothers who don't take advantage of the scheme. I know one who says that the child's tummy —it's an only child—is too delicate to digest milk. I don't believe it. Then there's a wartime scheme—an enormous social

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advance. The priority groups, the mothers and young children under five, are guaranteed their pint cheap, or if necessary for nothing. The other children get their half pint, plus their one-third of a pint at school. This scheme came in wartime and will, I am sure, stay in the peace which follows.

I have criticised many foods and so-called foods in my Kitchen Front talks, but never milk. Give twenty children an extra drink of milk a day and compare them with twenty without it. They are taller; they are heavier; they are healthier. Health can be bought in a bottle. An apple a day will keep no doctors away; but a pint of milk will, if it's given to children. Under 5's a pint at home, over 5's half a pint at home and a third of a pint at school. That's the stuff to give 'em. Take advantage of milk while it's plentiful.

Lastly, a word of warning. Germs like milk as well as human beings. Milk should be pasteurised or boiled. In many areas it's all pasteurised. Where it isn't, scald it and keep it covered in a cool place. No boiling or pasteurisation affects the food value of milk to any extent. See your milk is safe and for health's sake drink it.

What can we do with milk?

The colder the climate, the more fat people eat—or want to eat. In Greenland, for example, they eat twice as much fat as we do here, and we eat three times as much as they eat in Japan. One reason is that, weight for weight, fat gives us over twice as much energy as starches and sugars. We can get twice as much heat from it. Fat gives us a nice comfortable feeling—we feel we've eaten something. But fat, and this is what limits our eating of it, is less digestible than other foods.

Butter and margarine are good and digestible fats. Butter

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is made from cream by churning it up so that the fat globules run together into a solid mass. Then the fat ripens, as they say, with the aid of a few germs, and becomes butter. It's four-fifths fat and one-fifth water. Butter's not easy to keep in hot weather, unless you do what they do in India, and melt it and boil it until all the water's boiled off, strain it through muslin and cork it up; then it will keep indefinitely. But butter's something more than just fat—just fuel. It's got two vitamins—A, which protects us from eye and other troubles, and D, which protects us from rickets and helps to build strong teeth. What's left of the milk when the fat is taken away is, of course, fat-free milk, or butter-milk. It's quite nourishing. Before the war it used to be thrown to the pigs, but it's much too good for them now.

Now for margarine. What a change there's been in it. Twenty-five years ago it was pretty loathsome stuff, with a tang you couldn't escape. To-day it's difficult to tell it from butter. It used to be made from the fat of the ox: to-day it's made mainly from whale oil and the oil of nuts and seeds, like coconut. It's a cosmopolitan mixture, for the whale oil comes from the Arctic and Antarctic, and the coconuts and seeds from the Tropics. Now, regarded as fuel, margarine to-day is as good as butter. But some of it lacks the vitamins—or did before the war. To-day the vitamins of butter are added to all margarine, with the result that it's just as good as butter, in fact it's got more vitamin D than butter. As for taste—well, I can't tell the difference.

What else can we do with milk? We can take it as liquid or powder. We can make cheese from it. We can make butter from it. We can drink it sour. A number of people write to me from time to time praising sour milk. One or two praise it as a cure for all the ills to which flesh is heir. Koumiss is a continental sour-milk preparation: it's made from mare's milk. Sour cow's-milk, made sour by adding a germ which acidifies it, or by adding the acid itself, is often drunk in this country. It's a regular article of diet in Russia. Some people prefer the taste. It's probably more digestible than ordinary milk in certain conditions of the tummy. And there's often

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a little alcohol in the milk, too, made by fermentation. Perhaps that's what gives it such a good name, specially amongst the teetotallers. But, to take it by and large, as Commander Campbell would say, it's just milk with a different taste.

Lastly, a word about dripping—Monday's breakfast for many of us. Its food value and its energy value are just as good as butter's. What it lacks are those precious vitamins. Nevertheless, it's good energy food, and not a scrap should be wasted.

Cheese—can you beat it?

Yes, cheese is our one and only topic in this chapter. Did somebody say that cheese isn't worth a full chapter? He's wrong. For all too long we've under-estimated the virtues of cheese in this country. We've too often treated this valuable food as a titbit—we've trifled with a serious subject.

But first of all, what is cheese and how is it made? When milk is clotted, the protein—that's the building bricks in it—becomes stringy and solid and the fat of the milk or most of it, gets caught up in the clot. The milk becomes curds and whey—the curds being the protein and the fat, and the whey mostly sugar and water. If it's cows' milk and the clotting is done by rennet, the curd is Cheddar cheese—after some water has been squeezed out. If cow's milk is clotted instead with an acid, like vinegar, less fat gets caught up in the clot and the result is a less fatty cheese. If goat's milk, partly skimmed, is used, the result is Parmesan cheese. If cow's milk is used, we get Roquefort cheese.

After the cheese has been squeezed, it's put in a cool place to ripen. If it's squeezed lightly, you get a soft cheese. If it's squeezed hard, you get a hard cheese. The ripening is done by germs—and the flavour depends on the germ which does

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the ripening. At present it's largely rule-of-thumb, and the germ depends on the district. Stilton is due to one germ and comes from one district. Gorgonzola is due to another germ and comes from another district. But the scientists are getting busy and putting in the germ they want—so they can make any kind of cheese anywhere. If the cheese is sterilised by melting and some salts added, we get a packet cheese which keeps very well.

Now taking cheese as a whole, a third is fat, a third is building protein, and a third is water. Two ounces of cheese contains most of the building bricks and fat of a pint of milk. That's the secret of the value of cheese. Beef is more than two-thirds water—cheese is only one-third. So, weight for weight, cheese contains twice as much nutriment as beef. A cheese of 20 lb. contains as much nutriment as a sheep's carcase of 60 lb.

Now the difference between different kinds of cheese is just a question of flavour—just a question of the different bugs or germs which do the work of ripening it. Parmesan is, or was, about twice the price of Canadian cheese, but its food value is no more than that of Canadian cheese—in fact it's slightly less. Of course, if cheese is taken just as a titbit at the end of a meal—well, flavour is everything—you've already had your food. But if cheese is taken, as it should be in these days of austerity, for the food value that is in it, then it should be remembered that the food value of the cheapest cheese is as good as that of the most expensive, and the food value of the imported is as good as that of the home-made.

What about its digestion? Now, I think that cheese has got a reputation for indigestibility it doesn't deserve. As I've said before, the cheese taken at the end of a big meal gives its flavour to the wind which may be belched up—and it takes the blame for what has gone before. It was the whipping-boy of the eats and drinks of the pre-war city banquet. It must be chewed, certainly—and a soft morsel is always more difficult to chew than a hard one. So a piece of hard, dry cheese is easier to chew than a soft piece. And it can often be grated. But taken by and large, and properly chewed, cheese is quite

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digestible. A piece of toasted cheese for breakfast and a cheese sandwich for tea—why not? There's nothing odd about it, really; it's just that we haven't the habit. After all, beer was the breakfast drink at public schools not so long ago. So why not cheese for breakfast? Cheese has much more to commend it.

Yes, I'm all for cheese. If I were allowed to say only three things about the Kitchen Front, I should urge something green and raw every day, I should praise milk and more milk, and I should preach the qualities of that food which contains much of what makes milk what it is—cheese.

Green leaves make rosy cheeks

Do you suffer from soreness of the gums, looseness of the teeth, anæmia, pains in the joints, bruises on the skin, gloom, irritability, fatigue and giddiness?—If so, take our—no, not our pills. This isn't an advertisement for a patent medicine, after all.

Do you suffer from all these things? The answer's almost certainly "no," for these are symptoms of scurvy, that disease which used to worry sailors, explorers, soldiers in besieged towns, and all who lived for any time without fresh fruit or vegetables. Scurvy was Captain Cook's greatest enemy.

Scurvy is due to too little vitamin C—much too little. It's rarely seen to-day, though it was seen in a big northern industrial town in the last war. It sometimes happens in solitary bachelors and spinsters, living on their own, feeding themselves and doing for themselves. It has been seen in young men eating their mid-day meal in a city restaurant, and returning home to some warmed-up remains of a meal

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cooked hours before. Over-cooked or re-cooked food is the friend of scurvy.

But scurvy is so rare that the fear of it hardly troubles us. Scurvy's the whole hog, as it were. But the half hog isn't so uncommon. There are many who don't take enough vitamin C. They tend to be pale, to bruise quite easily, and to have poor complexions. An ounce of vitamin C is worth an inch of lipstick. It not only gives the skin a glow, but it helps it to heal. It keeps away infection, particularly from the so-called mucous membranes, such as the lining of the mouth.

"Well," you say, "where do I get my vitamin C?" Before the war you used to get it from your oranges, your lemons, and your grapefruit. You may have thought you got it from apples, but you didn't get much. Dietetically, apples are mostly skin and water (the Bramley Seedling, by the way, does contain some vitamin C). We got it from blackcurrants, rosehips, strawberries, raspberries, gooseberries and tomatoes, too—particularly from blackcurrants and hips. These are the fruits which were available then. Some of them you can get now, others are difficult to get. Eat all the fruit you can, but on the whole you'll have to go over to vegetables.

For a daily supply of vitamin C we must look first to raw vegetables—to raw cabbage-leaves, raw broccoli and raw brussels-sprouts, made up in salads. They are the cheapest and easiest way of making sure of regular daily vitamin C. Watercress and mustard-and-cress are good. Radishes and spring onions are not so good. Cucumber and lettuce are practically useless for vitamin C.

Most cooked vegetables contain vitamin C. They include broccoli, cabbage, cauliflower, kale, spinach, beetroot, runner beans and sprouts, but they must not be cooked too long or too much. The same with potatoes, turnips and swedes. For safety's sake, the green vegetables should be steamed for about 10 to 12 minutes. Put a little water in the bottom of the saucepan and cook with the lid on. Try your potatoes cooked in their jackets. Eat more of them, for vitamins' sake!

Now of all time, this is a time for salad vegetables. And I don't mean that slightly second-hand collection of wilting

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lettuce, with a suspicion of tomato and a chunk of cold potato, that sometimes masquerades as a green salad. It's better than nothing but it's not good enough. A salad should be freshly made, and if possible picked just before preparing. Go all out for the cabbage leaves, the watercress and the mustard-and-cress—all of them raw. To ring the changes, go in for endive, chicory and finely grated carrot, and raw beetroot, and young dandelion, or nasturtium leaves. If you want a hot meal—well, sprinkle some pepper on it.

Remember what happened to those London kids who were given an Oslo dinner instead of a good old English dinner. They had milk, wholemeal bread, butter or margarine, cheese and raw green and other vegetables. They literally bloomed. From green cabbage leaves to red rosy cheeks. From dandelion leaves to rosebud lips. From raw green to bright red—that's a miracle the human body can manage. If you give it a chance.

Do we eat too much sugar?

Little girls *may* be made of sugar and spice and all things nice, though as a father of three of them I hae me doots. Anyway, all of us have sugar in our bodies if not in our dispositions. Starches and sugars are the cheapest energy food we have. I've lumped them together—no joke intended, by the way—for however we take our starch, whether in bread or potatoes or rice; however we take our sugar, whether as sugar in our tea or icing on our cake (ha! ha!) all our starches and sugars have been turned into glucose by the time they get in our blood stream—that's the body's currency, so to speak. On average we get half our energy from starches and sugars. The poorer we are, the higher the proportion, for the simple reason that starches and sugars are cheap,

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particularly sugars. In Japan they get as much as four-fifths of their energy from starches and sugars.

For the moment I'll concentrate on sugars. Cane sugar is got from a special kind of grass, the sugar cane. Beet sugar comes from a root vegetable, the beet. These form the bulk of our ordinary white sugar. Maple sugar is tapped from the bark of a North American tree. Some people prefer the unrefined sugars, like Barbados or Demerara. But whether it's gran, or lump or castor—oh! blessed memory of the past —or brown or white, whether it's honey or barley sugar, or boiled sweets, it's sugar—fuel for the engine.

Treacle and golden syrup are by-products in the refining of sugar. They, again, are mainly sugars, with some iron and calcium as well. Toffee, by the way, is half sugar and half butter—or it should be. Many fruits contain their own sugar. Dates, figs, sultanas and currants, for instance—half to two-thirds of them is sugar. And prunes have quite a lot, too; they're nearly half sugar.

Now, do we eat too much sugar? Answer, "We do." Sir John Hawkins brought the first load of sugar to this country in 1563. Then it was a luxury. To-day it's something of a menace. There is sound truth in the quip, "Things sweet to taste prove in digestion sour." A hundred years ago, everyone in this country consumed about two ounces of sugar a week. Before the war, it was over one pound a week per head, and still rising.

Why is it a menace? First of all, sugar has no value other than the fact that it's sugar—that it provides energy. Other energy foods, like bread, potatoes, have got something else —some builder, some vitamins, some salts. The danger of sugar is that, at least in ordinary times, it tends to displace those other and better fuels. It satisfies the appetite which should be reserved for better things. Many doctors think that too much sugar is responsible for some of our bodily troubles.

Well, the war has cut sugar down, and that's a good thing, though it still leaves us a great deal. The snag is that many of us have a sweet tooth and we like it. But we can sweeten in other ways. To acid fruits, like rhubarb, you can add sweet

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fruits, like dates. Now that sweet biscuits are short, you can sweeten stale bread by putting it in the oven for a few hours—when the oven's on for another purpose. It should be warm but not enough to brown it. Here you break down some of the starch into a sugar. You can use saccharin: it's a harmless sweetener, though its energy value is nix. You can cut sugar out from your tea. Personally, I dropped it from tea some five years ago, and though I have a sweet tooth, I wouldn't give you a "thank you" for a cup of sweetened tea. But that's my funeral.

In moderation sugar's a good, cheap fuel. But there are better fuels and most of us eat too much of it.

Soup, soup, beautiful soup!

Someone once wrote to ask me why I never mention soup on the radio—good, hot, nutritious soup. She gives it, she tells me, to her boys every night when they come home from work. Isn't it good for them? she asks. The answer is, No! and Yes!

First—No! If it's a clear soup, made from meat cut up and simmered in water with the fat and the floating scum skimmed off, it's not much good as a food. The truth is that we just don't know how to get the goodness out of meat to make soup. We can boil out its flavour, its salts, its extractives as they're called, but we can't boil out those building bricks of protein that make meat the good food it is. To make it a meal, something must be added to the broth of meat or stock. You can add bones. By doing this you can boil out of the bones their gelatine. It's a building brick of sorts, but alone it's not much good. That goes for your calf's foot jelly as well.

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Secondly, you can add something to thicken the soup, like flour. Well, you've added starch and that at least gives it some energy value. But thirdly, and this is best of all, you can add vegetables. You can add lentils or peas, or potatoes, or turnips, or carrots, or cabbage, or cauliflower, celery or leeks. You can add cheese. You can add milk.

Now we're getting on to soups worth drinking because there's food in them. Boiling may kill a few of the vitamins in the veg., but it won't kill the salts. You'll notice that I mention lentils first. They make a grand soup and there's good grub in every mouthful. There's the No and Yes. No! to clear soups; and Yes! to soups with something added. Then why, you may ask, do people drink clear soup if there's no food value in it? The answer is, it's an appetiser. The flavouring and salts that have soaked out of the meat wake up your gastric juices and get them ready for what's to follow. As a Frenchman once put it, "clear soup is to a dinner what an overture is to an opera." I can't say I like this comparison between drinking soup and the music of the band, but let that pass. Clear soup's no use to a hungry lad. His appetite doesn't need titillating. By the way, the meat you use in making soup may lose its flavour and become a bit leathery, but most of its goodness is still in it. So whatever you do, don't throw it away.

Is hot soup better food than cold soup? Well, I suppose it's better because we like it better. But the plain truth is, the food value is just the same. A food isn't necessarily an energy food because it's hot, else a glass of hot water would be a good meal. There's more warming food in a cabbage leaf with a dash of salad dressing on it than there is in a basin of clear soup that's scalding hot.

What about extracts of meat like beef extracts? They smell like meat. They've got its flavour. But they've very few of its building bricks, for we just don't know how to get them out of the flesh. Meat extracts are flavourers rather than foods.

The same applies to meat juices, whether you make them at home by squeezing meat in a lemon squeezer or by adding cold water and squeezing it through muslin, or whether you

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buy them in a bottle. They haven't got the full value of the beef or anything like it. They are often useful for invalids, though white of egg is a better source of builders and much cheaper.

Then there's beef tea. Its value, such as it is, depends on how you make it. What you mustn't do is to bring it to the boil quickly. It should be made in the cold and heated very slowly. It's useful for people on a liquid diet—no, I don't mean those who pour out their lunch in the local. But don't let's exaggerate its value even to invalids. It's an appetiser; and, to give you some idea of its food value, you would need nine pints of it a day to get your daily ration of protein. Just think of it, nine pints of beef tea!

But there is one way of getting the food value out of meat, though we don't use it in this country yet. It's by drying meat to a powder. Yes, I know it sounds like sacrilege to shrivel a juicy steak to a powder; but dried meat would take up less shipping space than meat in the raw, and we are going into the question of importing a high-grade dried meat from U.S.A., where it is being used already.

There then is the story of soup. Meat may flavour it, but it's the other things in it that make it worth drinking—the lentils, the peas, the turnips, the swedes, the celery or the leeks and—dare I make your mouths water?—onions when you can get them.

Soft drinks and hard drinks

Next I want to talk about drinks, soft and hard. First, everybody's drink—water. I know some people boast that they use it only for cleaning their teeth, but they take it all the

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same both in their drinks and in their eats. Two-thirds of the body weight is water, and growing young men or women need at least a couple of pints a day to replenish what they lose. If they are doing hard, physical work or taking a lot of exercise, they need much more. Their thirsts will tell them what they want.

There's no danger of drinking too much water. Most of us could do with just a little more water than our thirsts suggest. And don't forget the value of a glass of water, as soon as you get up in the morning, in helping the bowels to do their job. As for minerals, in which young people delight, their food value is nil or nearly nil. If they're fizzy, that's carbon dioxide gas under pressure. If they're sweet, syrup has been added, and so on. The food value—napoo.

Now for tea, mother's standby at all hours of the day and night. A century ago our tea came from China; now it comes mostly from India. I haven't the cheek to tell you housewives how to make it, but please make it as soon as the water comes to the boil, and please don't let it stand for longer than five minutes.

What does it do for us? Well, it contains caffein, and caffein is a stimulant. It clears the head, it drives away that sense of weariness and it keeps us awake. One often heard bogey-men's stories of what tea can do to us, of what the tannin in tea will do to meat in turning it to leather, and so on. Don't you believe it. Most people of ordinary digestion can take properly-made tea two or three times a day—yes, even with a meat meal—without the slightest harm. I know some people say tea sends them all of a dither, but those people are usually all of a dither anyway.

As with tea, so with coffee, though it's said we don't know how to make it in this country. The food value of tea and coffee is precious little. They are stimulants, and in this weary world of ours we need stimulants. Cocoa, by the way, is hardly a stimulant at all. But it has some food value, though not a great deal. To give you some idea, you would need 75 cups of cocoa a day to give you the energy you need. Of course, cocoa made with milk is a different story: there, the goodness is due

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to the milk. So the moral is, don't think you are feeding your young people when you give them tea or coffee made with water. But you will refresh them, particularly after a long day's work.

Now for a word about a drink which is not a stimulant, alcohol. Yes, I repeat, alcohol is not a stimulant. It's a depressant. It blunts the higher centres of the brain. True, it may damp down your worries; but it also blunts your self-criticism, it weakens your self-control, it impairs the accuracy of your skilled movements. True, it is a food that's quickly absorbed, but it's a very expensive way of taking your food —and we don't ordinarily need to absorb our food at top speed. And alcohol doesn't warm either you or your young people up on a winter's night. That's a snare and a delusion. It does make you feel warmer, by increasing the rate at which you lose your body heat. The fact is it makes you colder.

Let me sum up. Water we must have, and most of us might well drink more. Ginger-pop and the like have little or no food value. Tea and coffee have no food value, but they are grand refreshers and stimulants. Cocoa has some food value, and a lot when made with milk. Alcohol is not a stimulant but a depressant. But don't think that a liquid can't be a food, for food number one is a liquid—milk, the best food and drink bar none; particularly for those who are still a-growing.

Menu for the ideal meal

Many good foods are named after the places they come from, or are supposed to come from, just as many good schools are named after the roads in which they are situated. There's Brussels sprouts, and Jerusalem artichokes. There's Cheddar cheese, and Ostend rabbits, and Eccles cakes, and French

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pastries, to say nothing of Bath buns and German sausages.

Then, there's the Oslo breakfast. It isn't really a breakfast; it's a meal you can take for breakfast, dinner, or tea. And its only connection with Oslo is that it was first tried out in an Oslo school. It reminds one of the May week at Cambridge, so-called because it's held in June and lasts a fortnight. Now, the Oslo meal isn't a good meal just because it's foreign. I know that some musicians add Poposki to their names because they think we will like them better if we think they're foreign. There are restaurants which describe their dishes in French, perhaps so that we will fancy that they're better than they are. But the Oslo meal is good British food—none better.

Here it is. National or wholemeal bread, milk, cheese, butter or margarine, and uncooked salad vegetables. How's that for a meal? It's cold, yes. But a meal isn't good because it's hot. And a hot meal doesn't give us heat to any amount which matters. There's no meat in it; but all the builders you can possibly need are in that cheese and milk and bread. Cheese, you'll remember, contains all the builders and most of the fat of milk. Milk is strong drink number one, and rich in builders and nearly everything else. And the National Loaf contains some builder as well as vitamin and iron. There's energy in the Oslo meal; and if there's not enough, you can fill up with potatoes to your heart's or your stomach's content. There's vitamins in it, particularly in the margarine, the bread, the milk and the uncooked salad. The Oslo meal is precious near the ideal meal.

You've heard what happened to the children who were put on the Oslo meal for dinner, and afterwards compared with the children on the good old English meat and two veg. with a pud. as padding. The Oslo kids felt fitter and they looked fitter—clear-skinned, bright-eyed, and full of vigour. They did better at play and at work. The Oslo meal's *better* than the hot dinner, and that goes for both children and grown-ups. Please, please don't think that veg. that are steaming are better than veg. that are stone cold. They're probably worse: if they're overcooked, they're certainly worse.

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By the way, there are variations that you can make in this meal. Obviously the grown-ups can't have the same amount of milk as the children. They can make up with a bit more cheese. You can add potatoes and cut down the amount of bread. Don't forget the virtues of the humble spud—energy, builder, and vitamin food. You can ring the changes in the salad vegetables. There's the tomato with its vitamins A and C. The carrot—here it's mainly vitamin A. Then there's the old gang, watercress, mustard-and-cress, broccoli tops and cabbage leaves; and my old friend, the dandelion leaf.

But, if the children have the cheese, the milk and the salad veg., they're having the best food that this world can give, in peace-time as well as war-time. This is an old story, I know, but I must repeat it until it's not only believed but acted on. If you can't tear yourself away from the hot dinner, then have an Oslo tea. Cheese, remember, is good food, whether it's taken at dinner-time, at tea-time or even at breakfast-time. Have you ever tried a bit of toasted cheese at breakfast? It's lovely.

How to feed a fever

I must start this chapter on Food for the Unfit with a word of warning. Don't let us exaggerate what food can do to cure disease. It plays its part, certainly. But in most diseases it's a small part. It isn't a panacea for all the ills to which flesh is heir.

The human mind is apt to jump at the simple explanation, and at the simple cause. We hear it said, for example, that

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the inflammation has gone in instead of coming out, that an illness dates from falling down the stairs a month ago, or the shock of seeing a dog run over a week ago. We are apt to exaggerate as well as to over-simplify, due in part to our lack of knowledge of how the body works, though sometimes it's due to a glowing pride in our own ailments. You know how superior troubles of the heart are to disorders of the stomach, at least in daily conversation; how our pneumonias are nearly always double; how our friends have been told by their surgeons how rare, how interesting was the tangle they discovered in peeping inside them. And so it is with food. We are apt to blame it and to praise it too much for what it does when we are ill.

First, our food in fevers, and by fever I mean all cases of temperature of any duration, and not merely fevers that take us to the fever hospital. I mean your 'flu, and your colds, as well as your measles and your mumps. In feeding fevers there has been a revolution. For centuries, in fact, right back to the time of the Greeks, starvation was the treatment for fevers. The temperature was due, they thought, to an irritation of the gut. Therefore, they said, starve the patient and rest the gut. Actually they fed him on wine and barley gruel—not bad for starvation. Then, in the middle of last century, came the revolution. Starving fevers was replaced by feeding them, and that is what is done to-day. The fever patient is fed with fluids or semi-fluids to the limit of his digestive capacity. Mind you, a food's none the less a food because it's liquid. But every liquid isn't a food.

Here are the rules for feeding; when there's no doctor in attendance, as for example, if you have a cold. Plenty of starchy or sugary foods. I mean, for example, rice or semolina, and mashed potatoes with gravy. Drink milk, egg and milk, and milk flavoured with tea. Within reason eat what you fancy, if you have got it. For breakfast or tea, make it bread and milk or porridge and a scrambled egg. For dinner mashed potatoes and gravy and milk pud., and some steamed fish if you can get it. If the appetite's poor, titillate it with some beef tea, unless there's diarrhoea. Don't drink beef tea in diarrhoea.

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If you are chesty, take your food hot. If there are colly-wobbles in your tummy, cut out the solids but take plenty of warm water. Keep off meat while your temperature is up. And drink plenty of water. Do fevers need alcohol? At one time a little brandy was the commonest medicine for the patient and sometimes for the nurse. Those days are gone. A man used to alcohol may need it to get him to sleep. The others don't need it in fever.

By the way, let me add a special word on milk, that standby in both sickness and health. True, there is some milk available as an additional ration in cases of sickness, but it's very, very limited. Your doctor *can* prescribe extra milk for you if you are suffering from one of quite a short list of complaints. But, unless your illness is in this list, there is no milk for you; so don't go on worrying your doctor for a certificate. The poor doctors to-day are hard pressed. Spare them wherever you can, particularly by not asking for certificates which you don't need, or to which you are not entitled.

Food fairy-tales

Does eating crusts make your hair curl? Does drinking egg water give you warts? Does an apple a day keep the doctor away? It's questions like these that are always cropping up in my post. Let me deal with some of them. What truth is there in these simple and attractive wrinkles?

"*An apple a day keeps the doctor away.*" Well, what's in an apple? It's over four-fifths water. And no doctor is frightened of water. The only food of any real value in the apple—if it's not a sour one—is a spot of sugar; a few grains in the ordinary apple, amounting to one-eighth of the apple by weight.

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For the rest there's a tit-bit of roughage, a spot of acid, a suspicion of fat and builder. Dietetically, the apple's a skinful of water with a trace of vitamin C. Only the Bramley Seedling contains much vitamin C. Apples are pleasant, they are refreshing, they help to clean your teeth. But they're as much use in keeping a doctor away as a roaring pneumonia. Now, if you say, "Something green and something raw every day keeps the doctor away," you're nearer the truth. That's if you *want* to keep the doctor away.

"*You get warts if you drink water in which an egg has been boiled.*" Now, how can you? Warts are little over-growths of skin. The egg-shell is mainly carbonate of lime. Lime does you no harm in small amounts. And it has nothing to do with the growth of your skin. This is an old wives' tale with a vengeance. And by the way, there's no real difference between eggs with dark shells and eggs with light shells. There's no justification for the belief that dark-shelled eggs are richer than light-shelled eggs.

"*National bread has a germ in it. Can this germ cause disease?*" That's a quotation from a letter to me. Confusion here arises because the word "germ" has two meanings. When you catch tonsilitis, it's germs—bacteria, bugs—which are wallowing in the cracks and crevices of your tonsils. When we speak of the germ of wheat we mean, not bacteria, not disease germs but the germinating part of the wheat grain, the part which grows to form the new plant. It's a bud not a bug.

"*Raw vegetables give children worms.*" They don't. It's worms that give children worms—worms taken by the mouth with the food or water we take in. Certainly unwashed vegetables, like other unwashed foods, may carry worms. But the vegetables themselves don't give you worms. In short, wash your green vegetables and salads.

"*Crusts make your hair curl.*" Well, well, well. Try it and see. Think of the poor perpetrators of permanent waves if this were true. But, alas, it 'aint.

"*Oranges and other fruits give children acidosis.*" Well, I won't worry you with details of acidosis, which was all the rage years ago. But I can assure you that because fruit tastes

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tart, because it contains acid, it doesn't mean that it gives children acidosis. Don't deprive them of any blackcurrant juice you can get because of this bogey.

"*I don't feel I can take live vitamins.*" someone wrote. We must get clear that vitamins aren't alive. They are chemical substances which are present in many natural foods, and without which the body can't be healthy. Many of them can now be prepared by the chemists in their laboratory. They aren't alive; and in any case, a digestion which can take Stilton cheese when it's all "alive" wouldn't be disturbed by a few vitamins—if they were alive.

Those are some of the myths which our gossipy friends, the astrologers of dietetics, would have us believe. We no longer fall for the one about the gooseberry bush and the part it plays in our birth rate. We no longer believe that for a child to pick dandelion leaves is to stimulate its kidneys beyond hope of control. So don't let's be taken in by the fairy tales of feeding.

A matter of taste

This chapter I want to start with a poem. It's by Hilaire Belloc:—

"Alas! what various tastes in food,
Divide the human brotherhood!
Birds in their little nests agree
With Chinamen, but not with me.
Colonials like their oysters hot,
Their omelettes heavy—I do not.
The French are fond of slugs and frogs,
The Siamese eat puppy-dogs.

And all the world is torn and rent
By varying views on nutriment."

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Well, what are these varying views on nutriment? First, I think, comes vegetarianism: it's a *different* view, held by a good many people. Some of the arguments for it are moral and æsthetic: that animal food is revolting, that meat-eating involves cruelty in the killing of animals. That's a matter of conscience rather than of physiology. The second argument for it is that it works. Whether you look in the fields of physical or intellectual activity, you find vegetarians among the giants. There are three main varieties of this system. There are the fruitarians, who eat fruit only. There are the vegetalians, who eat fruit and vegetables only. And there is the normal vegetarian who eats, in addition to fruit and vegetables, milk and its products, butter and cheese and eggs.

Now, fruitarianism—there's no sound argument for this. The ape may live only on fruit, but it doesn't follow it's good for man. To obtain the energy you need and the builders you need from fruit, you would have to eat simply enormous quantities. And the builders in fruit, such as they are, are not really good enough for man—at least as his only builders. Neither your stomach nor your purse is big enough, even in the days of plenty.

The vegetalian lives only on fruit and vegetables. Here again the vegetables are too bulky, and the builders aren't good enough, though in beans and lentils they are pretty good. It's not a satisfactory diet.

Thirdly, the normal vegetarian. On dietetic grounds there's nothing at all to be said against excluding meat from the diet, provided you replace it by cheese and eggs and milk. I don't like the meatless diet every day because I find it insipid: it lacks flavour and taste. But the fact remains that you can get from cheese and milk and eggs all you can get from meat. You can be vegetarian and absolutely healthy. It's all a matter of taste.

Now for one or two fads. There's the unfired food fad. Its adherents argue that no animal cooks food. Man is an animal, therefore man should not cook. Well, the other animals don't talk or read or wear clothes. Is that any reason why man

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should copy them? The fact is that cooking improves the flavour and digestibility of the food. It often makes it safer. It gives it variety. Then, there's the fad of incompatibility —that some foods should not be eaten with others. In Canada it is widely held that you should not drink milk at a meal at which you have stewed fruit. The acid of the fruit would curdle the milk. Well, the acid of the stomach is going to do it anyway. It's just a fad.

Then there's the system of dieting which says, "You mustn't eat building food, like meat and cheese, at the same meal as sugar and starch. Meat and potatoes is a dietetic crime. Those much-married foods, bread and cheese, must never be seen together!" Dietetically this is bunkum. It's the only word for it. The only thing to be said in its favour is that it may make some people eat less. The prosperous business man found himself cut down to a glass of milk and a little fruit or salad. He ate less and he had more vitamin foods. He was the better for the starvation: the incompatibility, so-called, had nothing to do with it.

Lastly, is there anything in the slogan, "Never drink at meals," or in the other one, "Never drink between meals?" Of course, it's wrong to wash food down with copious drinks at a meal-time. The saliva doesn't get a chance to do its work. But for the ordinary man drinking ordinary amounts of ordinary drinks, particularly water, the fact is that it doesn't much matter whether you drink with your meals or between your meals. Please yourself—there's some welcome advice for you.

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"It isn't comfort we're after. It's winning this war — and using our food to keep us fit to win this war." *Lord Woolton*

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DEFENSE

WORKING TOGETHER FOR VICTORY

[c 1944?]

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BRITONS
do without...

so must we in
WEST AFRICA

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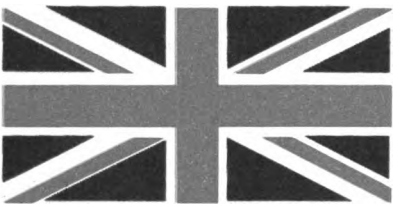
Wars are not only won by what we do, but by what we do without. People in Britain and other parts of the British Empire are doing without many of the things they had in peace time, for only in this way can Victory be won. We in Africa must also do without many things, for the war is a period of sacrifice by all for Victory.



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New clothes mean

AND THIS IS WHY. . .

Wool is required for making army uniforms. Cotton is needed to make tropical kit for fighting men. Silk is wanted to make parachutes for the Royal Air Force.
The men and women who make clothes in peace time are required in war factories to make essential munitions and army equipment.

Make do with

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waste of shipping

your old clothes!

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Rubber is needed

AND THIS IS WHY. . .

In a modern war, rubber is required for millions of army vehicles. Cars, lorries, trucks. Gun carriers, jeeps, armoured cars. All these need rubber tyres. Aircraft, and the dinghies which save the lives of so many pilots, also take rubber in their manufacture. Rubber is an important munition of war.

Give old rubber

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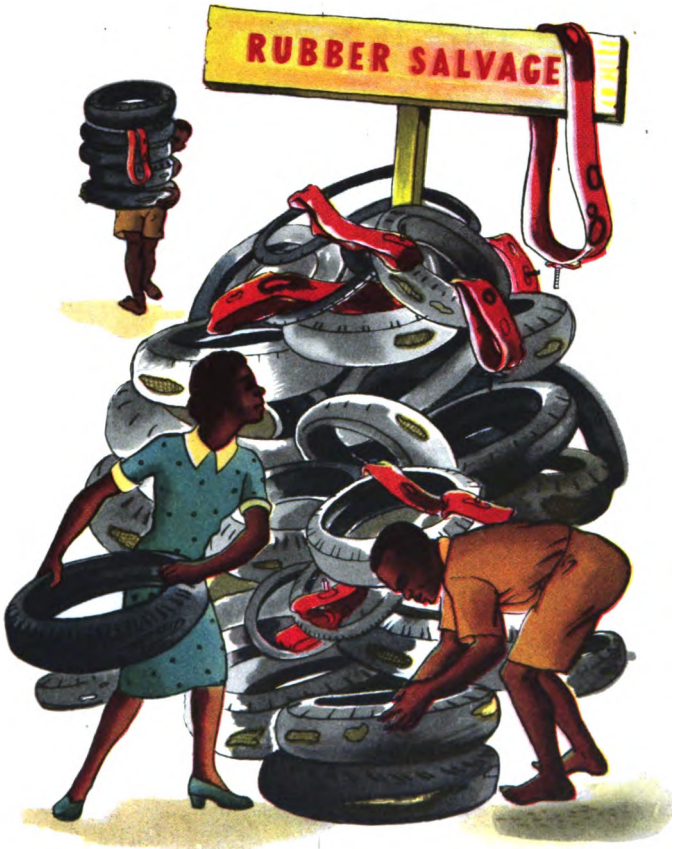
for army equipment



tyres to salvage

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Most imported foods

AND THIS IS WHY. . .

In order to save shipping space,
and so enable ships to carry
the maximum number of troops to
the battle-fronts, and equipment
and raw materials to factories
and shipyards, every inch of land
must be sown with nourishing food
that everyone can buy.
No more bananas, melons, grapefruit
or other luxuries are shipped
to Britain to-day.

You too should eat

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are luxuries

more home-grown foods

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Building in war time is

AND THIS IS WHY. . .

Timber, metal, bricks and cement can all play a more useful part in the war effort than that of making new houses. The Allied armies need these materials to build temporary quarters for their troops. Timber is needed in the shipyards, metal is required for armaments, bricks and cement are wanted for air raid shelters and defence posts.

Use local materials

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waste of raw materials

for essential repairs

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Every man and woman

AND THIS IS WHY. .

Certain industries in war time, such as aircraft and munition factories, coal mining and shipbuilding, require additional labour. Luxury trades, such as those manufacturing jewellery, fine clothes and perfume, are not essential. In Great Britain to-day many factories which previously produced luxury goods have been closed down. Workers in many parts of the British Empire are sent to new jobs, essential to the war effort.

Working harder means

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must work for total war

fighting harder

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Bicycles are difficult

AND THIS IS WHY. . .

Every part of a bicycle is made from material required for more serious needs in time of war. The metal of the framework is wanted for guns and tanks, ships and aircraft. The rubber of the tyres and pedals is urgently needed for making larger, more important tyres — those used by the thousands of army vehicles on the battle fronts.

Keep yours in

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to get in war time

good repair

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Sewing machines are

AND THIS IS WHY. . .

Great Britain not only clothes her own Army but also helps to clothe those of the Free Allies. She sends large supplies of clothing to Russia. Sewing machines are still being manufactured, but they are urgently needed by the many army clothing factories and by the workshops in which parachutes and barrage balloons are made.

Savings will help to

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not available now

buy one after the war

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Gramophones are unne

AND THIS IS WHY. . .

Gramophones are a luxury in war time, since their manufacture takes metal needed for munitions and machine tools. The men who, before the war, were employed in adjusting the delicate mechanism of a gramophone motor, are now doing more important work on the equally delicate mechanism of instruments of war.

Leave manpower and

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✓ GTA Journal

essary war time luxuries

materials for munitions

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But here's something we all can buy...

let's do it!

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BROADCASTS

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ISSUED FOR THE MINISTRY OF FOOD
BY THE MINISTRY OF INFORMATION

The First Year

LONDON, 1942
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3 The next best thing : *page* 9

4 Something more substantial : *page* 14

5 V for vitamins : *page* 17

With a table showing the right foods to give your child from one year onwards : page 20

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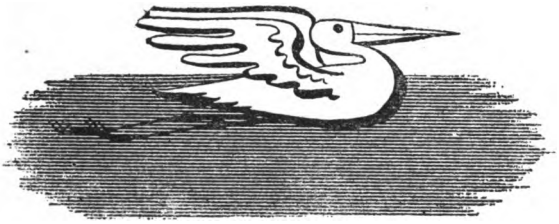

(1) *Food for One and a Bit*

If you are a grown-up all the vitamins and the calories, the proteins and carbohydrates, however neatly mixed up, artfully flavoured and comfortably digested, won't add one hair to your head or one inch to your stature.

True, the right food will make you fitter, healthier and stronger—up to a point. But you must face the fact that your physical prospects in this world were laid down for good or for ill when you were a child.

On a long-term policy, what matters most of all in this world is the diet of those whose bodies are in the making—and not the diet of those who are the finished, or nearly finished, article. Dietetically we grown-ups don't matter much.

So here goes. I am going to talk about the feeding of young children. If there are no young children in your house,

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if you don't offer advice to your friends and relations on the feeding of their children, if you're quite sure you aren't going to have any children—well, I'm not talking to you.

Now the life of a child starts nine months before it is born. Birth is, so to speak, an incident when the child changes its life under cover for life in the open. For its first nine months the child lives as a parasite on its mother—yes, a parasite—drawing its oxygen, its food and its drink from her tissues. The mother-to-be needs food for one and a bit, the bit being the growing child. Charity begins at home and infant feeding begins with the feeding of the expectant mother.

There is nothing special about her needs. Pregnancy needs no pills or potions or patent medicines. It doesn't need a bottle of stout or a life of leisure. Pregnancy isn't an illness—it's something natural and healthy. What the expectant mother really needs is peace of mind and an ample mixed diet, with an emphasis on certain foods.

The child is forming blood, so mother needs iron. It is forming bone, so she needs lime. It is forming flesh, so she needs flesh-making foods. She needs vitamins in abundance, for these are the keys of the healthy life. That's how a doctor would put it.

Now for how the housewife would put it. She needs at least a pint of milk a day, and Lord Woolton has made it certain she will get it.

She needs meat, but not too much—with liver quite often. Cut meat down in later months. She needs cheese and butter or margarine—her full ration, with no one else poaching on it. She needs wheatmeal bread, with its vitamin and its iron. She needs fish—sea fish—twice a week. She needs eggs, and here she can borrow her husband's rations. He can do without them. His food's not supporting two human beings, anyway.

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She needs the vitamins and salts that come from vegetables and fruits, some of them uncooked. Remember the vitamin virtues of blackcurrants and tomatoes, of broccoli tops, watercress, mustard and cress, cabbage, sprouts and spinach. She needs salt with her meals.

Lastly, she needs three pints of water a day. Remember, the nipper's body is mainly water. She does *not* need alcohol—and she shouldn't have it. She shouldn't have strong tea or fried foods.

Does she need anything to help her breast milk along? She doesn't. In any case there's nothing that really does it, except good food and ample fluid.

Now for the child. The best food bar none is breast milk. It's easier, it's cheaper and it's better than anything else, and there's no rationing. It contains just what the baby needs in the right amounts. It's free from germs. It needn't be pasteurised. It's served up piping hot—well, anyway, at the right temperature. For every breast-fed infant that does not live, five die that are fed other ways.

Most women can do it if they try. A lot of them pretend they can't because they don't want to, they can't be bothered, or they think it isn't quite nice. That's folly, almost criminal folly. Why rob the calf, when nature has given you infant food number one?

There are the arguments for breast-feeding, and they're overwhelming. Next I'll go more fully into the art of breast-feeding, the times, the amounts and so on. Later I'll deal with bottle-feeding and with weaning.

* * * *

Remember, human milk was intended for human beings, and cow's milk for cows.

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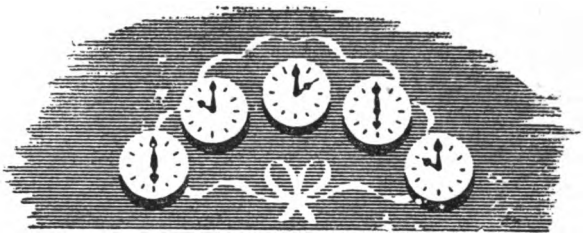

(2) *Nature's Food First*

I HAVE spoken about the feeding of the unborn child, in other words of the diet of the expectant mother. I stressed the importance of breast-feeding the newly born child. Now, I want to go more fully into the story of breast-feeding.

For the first three or four days after the child's birth there will probably be little or no milk in the breast. The animal must go without, and it will do him no harm. But despite the absence of milk the child must be put to the breast regularly. It is the sucking of the hungry child which brings the milk along and keeps it going once it arrives. It's the child who really delivers the goods.

It should be put to the breast six hours after birth and every six hours in the first day, and after that every four hours until the milk arrives. Let the hungry little rascal suck for a few minutes and then as its reward give it boiled water with a spoon. Yes, life is hard in the first few days, but perhaps it is no harder than it will be later on.

By the way, you will notice that I said "with a spoon." If it's ever necessary to give a breast-fed child anything

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additional, whether it is water or milk, it should always be given with a spoon. The reason is quite simple. It is easier to suck liquid from a bottle than from a breast. Babies aren't as daft as they look, and they soon discover the easier ways of life. If they know that if they wait they will get a bottle, then they won't trouble to work at the breast. We're all born lazy.

Well, on the third or fourth day the milk appears. Then feed by the clock, with no nibbles between meals. If it's four-hourly feeding, and that is sufficient for most babies, let it be fed at six, ten, two, six and ten—and no waiting. And no feeding during the night, unless, of course, you like pacing the lino at two a.m.

The child soon learns when it can expect a feed. Start night feeding and your sleep is ruined, to say nothing of the old man's. If the baby does wake and cry, give it cold boiled water only.

At each feed put the child to each breast for ten minutes, starting on one side for one feed and the other side for the next, and so on. And then hold the nipper on his tummy over your shoulder, patting him on the back while he enjoys his little belch. After feeding empty each breast by hand. An empty breast will fill in time for the next feed.

For its first five months of life the child needs nothing else but breast milk, except a little fish-liver oil and fruit juice every day from a month old onwards. If you can't get orange juice or tomato juice, the juice of a sweet turnip or a potato will do as well. Later I will tell you how to do it.

How can you tell if the baby's getting on? First of all, it looks as if it's getting on. Secondly, it's putting on weight. For the first three months it should gain from four to six ounces a week. After that about four ounces a week.

It should be double its birth weight in about five months,

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unless it was a very heavy baby at birth. Here's a figure worth remembering. One pound of baby needs two and a half ounces of breast milk a day. So a ten-pound baby, or a baby who should be ten pounds, needs twenty-five ounces of milk a day. If it's fed five times a day it needs five ounces of milk a feed.

If you are doubtful whether it's having enough, weigh the baby before and after feeds for every feed on any one day, so you can check up whether each pound of baby is getting its two and a half ounces of breast milk.

How do you know when the baby's had enough? Usually the baby knows. It gets almost all the milk it wants in the first few minutes at the breast. Keep it there for the full twenty minutes, however, to make it tired. If it's a greedy baby, taking more than it can hold, it will vomit some of it back; you can damp its appetite with a little boiled water before each feed.

If it fails to gain weight, and it cries after the feed or before the next feed is due, it's probably underfed. Your doctor or your infant welfare centre will advise you what to do.

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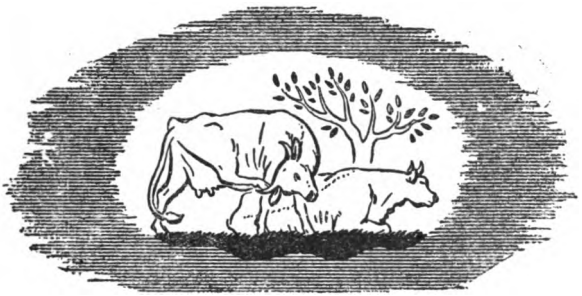

(3) *The Next Best Thing*

NEXT, the story of the bottle—the milk bottle—the baby's bottle. For some reason or other this baby of ours can't be breast-fed. Perhaps the mother isn't fit or the milk isn't there, or perhaps she just won't.

What's to be the second best, if breast milk's not available? Is it to be goat's milk, or mare's milk, or buffalo's milk? No, "Don't get me wrong," as Max Miller would say, these milks *have* been used to feed babies, and with success. Then there's ass's milk. And it's very like human milk. I won't go into the implications of that surprising fact, but it's true. Then, of course, there's cow's milk, intended for cows. The doctors know it contains more protein than human milk and these proteins are different. Put more simply, cow's milk forms more curd than human milk and that curd is different. It contains less sugar. It contains about the same amount of fat. It contains more germs.

Is cow's milk, then, fit for babies? Unboiled or

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unpasteurised, it isn't. Boiled or pasteurised, it's grand food —with a little modification. True, many babies can take it neat and do well on it—perhaps a tribute more to the fortitude of the human frame than to the virtues of the milk. Human stomachs stand a lot—particularly from grown-ups! But it's wise, at least at first, to modify the cow's milk.

It can be diluted with water so that there's less curd per ounce. This means less fat per ounce, but that doesn't matter. Fat causes more digestive troubles than anything. Dilution means less sugar per ounce of feed, but that can be made up by adding sugar. But there's a limit to dilution. If the mixture's too watery, the child's tummy is full before its hunger is satisfied. The usual method is equal parts of milk and water for the first few weeks; then one part of water to two of milk; and then, three months later, neat milk.

But some people like to do more than this. They like so to alter the cow's milk as to make it almost like human milk in composition. I said "almost," because it can't really be done properly. They dilute it with whey, they add cream and sugar and lime water in certain amounts. They're trying to *humanise* the milk. It's a lot of bother, and in my view it's not worth it. Cow's milk—even diluted—may not be the same as human milk, but the ordinary babies can take it. Sorry, I know your baby isn't ordinary.

Another way of dealing with that cow's milk curd is to add a little lactic acid to the milk. It makes it light and feathery, and there's no need to dilute the milk with water.

I'm all in favour of lactic acid milk, but I'm bound to admit that the healthy child will thrive on most methods of milk feeding. Cow's milk, undiluted or diluted, with sugar added; humanised milk; lactic acid milk; butter milk—the healthy child thrives on 'em all. I'm all against sweetened condensed milk—it's bad for infants.

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Now for dried milk. It's every bit as good as liquid milk and in many ways even better. It's more convenient and easier to keep. It's been dried by heat, so it's germ free. Usually one part of dried milk to eight of water gives you liquid milk as from the cow: it's full cream or half cream according to the kind. The curd is soft. Dried milk with sugar added—ordinary sugar—is as good a feed as any. Personally I like half cream dried milk with sugar—it's just right for most nippers.

Which is the best, you ask. Well, mothers differ, children differ, to say nothing of Grandma and the woman next door. Doctors must decide in individual cases. But, in general, *most* children thrive on *most* varieties of milk feeding provided they get enough: provided, if it's liquid milk, it's pasteurised or boiled: provided there's enough total fluid for the day, be it milk or water: and provided something extra is taken to make sure of the vitamins.

Presently I'll go into more details. But a word first about weighing. Normally the baby should put on four to six ounces a week at first and four ounces later. But don't be a slave to the weighing machine. Is the baby well?—is it a good colour, is it contented, are its stools normal?—you mothers can tell if it's O.K. Don't break your hearts if it puts on a bit less or a bit more one week—provided the baby looks well.

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Now for the story of the milk bottle—instalment two. Let's follow the example of the Ministry of Food in its food advertisements, and get down to actual details.

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How much milk does a baby need a day? When should it be fed? Here are some figures to remember—

One pound of baby, of anybody's baby, needs every day 1¾ ounces of cow's milk, plus one flat teaspoon of sugar. Make up with water to not less than 2½ ounces of fluid per pound of baby.

The rest is just arithmetic. Obviously a ten-pound baby needs ten times 1¾ ounces of milk—that is 17½ ounces a day. In addition it needs ten level teaspoons of sugar a day. Make up to ten times 2½ ounces with water—that is, make up to 25 ounces with water.

A word about the water. In the first month you would probably mix the milk with equal parts of water, and in the next few months make it two parts of milk to one of water. While you're doing this the baby is getting the fluid it needs, and you need think only of the milk and sugar. The water looks after itself. But when the baby's on neat milk, or dried milk, you must make sure that the total fluid the baby gets each day, whether as milk or water, is not less than 2½ ounces per pound of weight.

Now there's one snag. Our baby is being fed by weight and not by age, and that's the proper way. It was when babies were fed by age that someone produced the tag "Little babies do better than big babies." Both do well if they are fed by weight. But if a baby weighing ten pounds should really weigh twelve pounds we must obviously feed it as if it were a twelve-pound baby. If it's healthy, it weighs ten pounds rather than twelve pounds because it's getting the food of a ten-pound baby rather than that of a twelve-pound baby. So that if your baby's under weight, you should work out roughly the weight it should be.

How can you find that out? Well, a baby loses weight for

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the first few days, then it puts some on, so that at the end of the first week it is about its birth weight. Then it puts on five or six ounces a week for fourteen or sixteen weeks, and four ounces a week after that. If your offspring is doing something like this, then all is well.

As a check you should know that a baby of average weight, in the region of seven pounds, doubles its weight in five months. So you can work out roughly what it should be and base your feeding on each pound of the ideal weight.

Let me wind up with a few tips. Four-hourly feeding is good enough for most babies. No feeds between 10 p.m. and 6 a.m.

If you're giving dried milk, then one piled teaspoon, or better still one measure, of dried milk equals an ounce of liquid milk. So each pound of baby needs 1¾ piled teaspoons or measures of dried milk, plus one flat teaspoon of sugar, plus 2½ ounces of water.

Wash the teats and bottles after every feed, and keep them in water between feeds. With the bottle nose down, the teat should let through water at about sixteen drops a minute. The feeds should take about ten minutes. If the hole is too small, make it bigger with a red-hot needle. If it's too large, buy a new teat.

If the feed is liquid milk, make it up for the full twenty-four hours, starting with the feed after the milkman arrives.

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(4) *Something More Substantial*

OUR baby's now five months old. It's a fifteen-pounder—a big, bonny, bouncing article, which sits up, chuckles, gurgles and dribbles, with its first tooth in the gums—at least that's what it should be like.

It's fed up, in more ways than one, with milk, whether from the breast or the bottle. It's having about twenty-five ounces of milk a day, and no healthy person, man, woman or child, needs more than that. It's tired of feeding by suction—it wants to chew.

Well, from the milk stage it passes first of all to the semi-solid stage. I will speak of the breast-fed baby, and what I say can easily be applied to the bottle-fed baby.

The fifth month is the month of extras. We add something extra to the feeds at ten, two and six. We give gruel or porridge before the ten o'clock feed, starting with a couple of tablespoonfuls. A week or so later we give a few spoons

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of vegetables before the two o'clock feed, giving spinach, or sprouts, or cabbage, or carrots, or turnips—mashed, and if necessary sieved. Purées of vegetables are excellent. But no potatoes until the baby's a year old. A week or so later we give gruel or oatmeal before the six o'clock feed.

Our babe's now six months old. The next month is devoted to replacing the three feeds by the extras, leaving only the early morning and the late night breast feeds. We replace the ten o'clock breast feed by gruel, made up, of course, with milk, plus about six ounces of milk as a drink.

We replace the two o'clock feed by a full vegetable feed, with meat juice, bone broth, or gravy—real gravy, not just browning material from a packet. Again we give six ounces of milk as a drink. The six o'clock feed is the same as the ten a.m. feed.

All this semi-solid food, by the way, we give with a spoon —the milk with a spoon or from a mug. Don't give a bottle unless you must.

It's now seven months, and our baby's having three semi-solid meals and two breast feeds. Towards the end of this month we drop the night breast feed and later drop the early morning feed, at the same time adding more milk to the ten o'clock and the six o'clock feeds, so that our child is getting not less than a pint a day.

Now for the 9–12 months period. We turn the ten o'clock feed into breakfast, giving gruel and, as a second course, a lightly boiled egg or fried bread, and perhaps a little later some chopped bacon—with a crust or bread and butter, washed down with milk.

The two o'clock feed becomes dinner, with, added to the vegetables, a little fresh mincemeat, or steamed fish, or brains, or liver or tripe. Babies can take meat much earlier than many people think.

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The six o'clock feed becomes tea, with groats, a little wholemeal bread and butter, a rusk, a crust with a little honey or jam, and milk as a drink. After a bit the groats are dropped. Our child is growing up. Suction has gone and chewing has arrived.

What would happen if you put a variety of grown-up foods before six-months-old babies and let them eat what they wanted? Well, it's been done. Not one of the babies refused to eat. They tackled everything. They ate the paper d'oyleys and the spoons. One took a bite out of the tray and another chewed the saucers. They tackled *all* the foods. One child ate a plate of liver, washed down by a pint of orange juice. At least they weren't fussy. They seemed to have no likes or dislikes. It's clear that babies aren't born with an instinct to choose the right foods. They will eat most things if faced with them.

Here are a few tips. Don't force a child to eat anything. If it refuses a dish, take it away without comment. Let it go without. And don't refuse to eat what you expect the child to eat. Don't let it know that you loathe tapioca, that you can't stick parsnips, or that you abominate spinach. Don't talk about likes or dislikes, either yours or the child's, in front of the child. Don't say "Try this—it will do you good." Put it there and see what happens. And no nibbling between meals. In fact, nothing but water. And please, mothers and fathers, don't quarrel at the table, for your sake as well as the youngster's.

One last word. A child who is having every day a pint of milk, plus some meat or fish or cheese, some wholemeal bread and butter or margarine, and something raw in the way of vegetables or fruit, that child is probably well fed. And it can be done on the rations. If it isn't having these things it probably isn't well fed.

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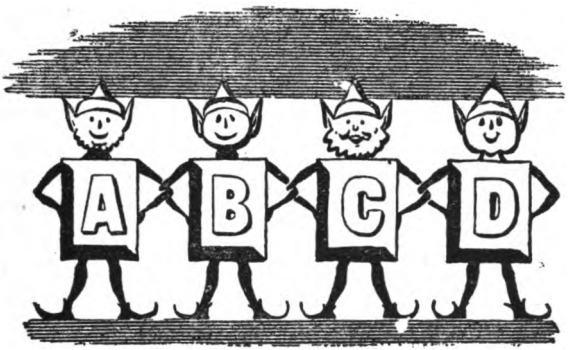

(5) *V for Vitamins*

"LOOK after the little things in life and the big things will look after themselves." I heard this little tag when a boy at school until I was sick of it. I thought it sounded uplifting but inaccurate. But I am bound to say that in matters of food in war time it rings absolutely true.

If you put a rat or a child—no, I'm not comparing them—on a diet of the purest prepared food, scientifically purified in the laboratory, it won't flourish; it will probably fade. Put it on natural foods, with something raw thrown in, and it will probably thrive. The natural, and particularly the raw, foods have got a little something the others haven't got—and that something is vitamins.

In peace time I should have said "Give your babies fish-liver oil and orange juice, and yourself have a mixed diet with

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wheatmeal bread, and milk, and butter, and cheese, and meat, with fruit and raw salads—and forget the vitamins."

In peace time we can think of the big things and leave the little things to look after themselves. But not so in war time. Our range of foods is limited and we must make sure of the little things. Remember, it was shortage of vitamins that played a big part in the German collapse in 1918 and for much of the disease which followed the war. V stands for Vitamin as well as Victory.

Now for the brass tacks. There are four vitamins we must know about. Vitamins A, B, C and D. Shortage of A may mean eye troubles, ulceration of the mucous membranes, or even night blindness. Shortage of B may mean nervous disorders and skin troubles. Shortage of C may mean scurvy. Shortage of D may mean rickets and bad teeth.

"Oh!" I can almost hear you say, "you're telling me! Scurvy is rare: rickets you hardly ever see. I'm not paralysed and I can see quite well in the dark. What about it?" Of course I know that extreme vitamin shortage is uncommon nowadays, and the Ministry of Food is keeping it uncommon.

But remember this. Put twenty children on a mid-day dinner rich in vitamins, such as wheatmeal bread, butter, cheese, salad and raw carrot, and compare them with twenty children on a good old-fashioned dinner of roast and two vegetables and you will see a difference. The vitamin kids will be bigger and better and fitter. They will literally bloom.

The truth is that while a slight insufficiency of vitamins may not mean serious disease, it certainly means the difference between being really fit and just jogging along, between feeling fine and just middling.

Remember, A for eye troubles, B for nervous troubles, C for scurvy, and D for rickets.

Now let's apply this to our child. If the mother's properly

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fed, breast milk contains all the vitamins. Cow's milk, even though it has been pasteurised or boiled, contains them, although the vitamin C is partly destroyed by the boiling. Dried milk contains them, but again drying destroys some of the C. But for safety's sake every child should have extra supplies of A, C and D from a month old. After all, rickets is still found in both breast- and bottle-fed babies, even to-day.

Fish-liver oil, whether from the cod or the halibut, is rich in both A and D. With cod-liver oil, start with a teaspoon at a month old. Increase it to two teaspoons at two months old, and keep the fish-liver oil going until the child is running about. My children have it until they are five. And there's no shortage. With halibut-liver oil you will need less—you'll find instructions on the bottle.

Vitamin C is more difficult. Before the war we could give three or four teaspoons of orange juice or tomato juice every day. That's difficult now. The swede and the potato are fairly rich in vitamin C. They can be mashed or crushed, pressed through muslin, and the raw juice given in place of orange juice. But, better still, America is sending us, under the Lease-Lend Act, concentrated orange juice. The Ministry of Food has put by quantities of blackcurrant purée made from this year's crop—yes, that's where they went. One or the other will be available to children this winter—both are rich in vitamin C.

We have now brought our child to its first birthday. May I throw in as a last suggestion something which has nothing to do with the youngster's food, but may have a great deal to do with his future health? Have him immunised against diphtheria. That's a little thing which prevents a big thing. Yes, there's something in that old tag after all.

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From One Year Onwards

THE diet of older children, like that of grown-ups, must satisfy three needs of the body :—

(1) For warmth and energy.

(2) For building new tissues and repairing old ones.

(3) For protecting against disease.

There are set out below the main warmth and energy foods, the main building and repairing foods, and the main protectors, or foods which protect against disease. To be healthy your diet should include food from each group. Where a food is not available because of war-time shortages, try to use another *in the same group*.

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1 FOODS FOR WARMTH AND ENERGY

Sugar
Bread
Flour
Oatmeal
Potatoes
Cakes
Biscuits
Jam
Syrup
Treacle
Honey
Dried fruits
Dried peas
Dried beans
Lard
Frying fats
Dripping
Butter
Margarine

2 BUILDERS AND REPAIRERS

Cheese
Milk
Eggs
Cereals
Meat and so-called offal
Fish, including herring and cod roe
Pulses (dried peas, beans, etc.)

3 PROTECTIVE FOODS

Milk
Butter
Cheese
Eggs
Vitaminized margarine
Fish, particularly the fat fish (herrings bloaters kippers sprats mackerel salmon sardines and eels)
Salad vegetables:
Lettuce
Mustard & Cress
Radishes
Tomatoes
Watercress
Green vegetables
Carrots
Swede turnips
Potatoes
Oranges
Currants
Gooseberries
Loganberries
Raspberries

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